

VOL. XXXI.

PART 2

The **JOURNAL** Of The Department **of AGRICULTURE** VICTORIA AUSTRALIA



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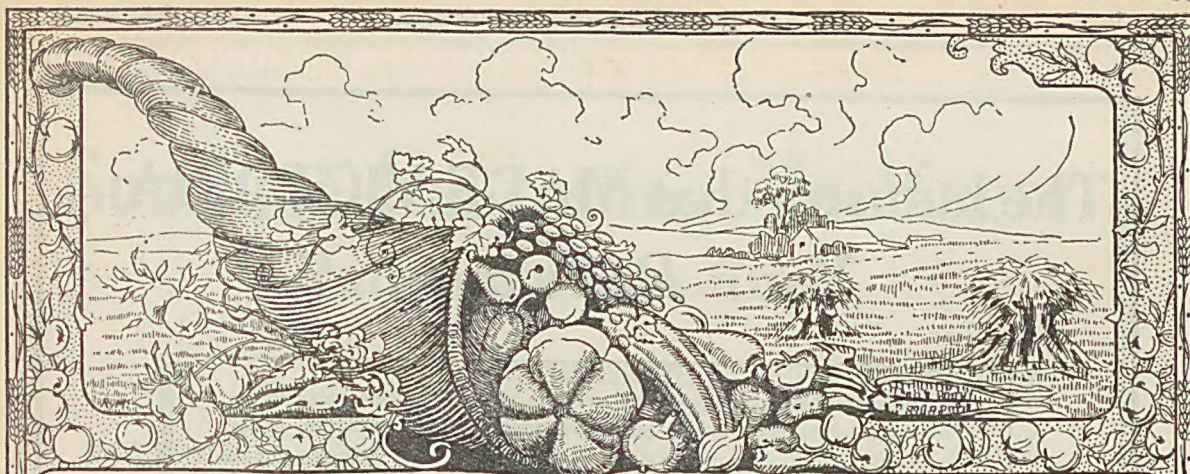
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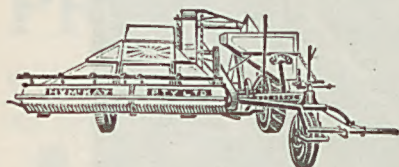
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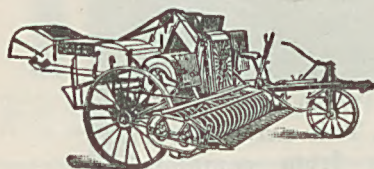


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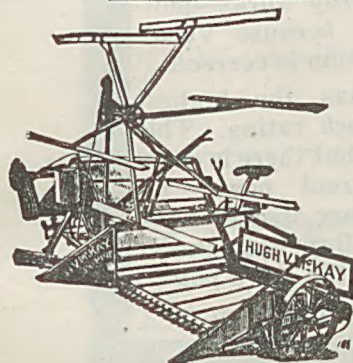


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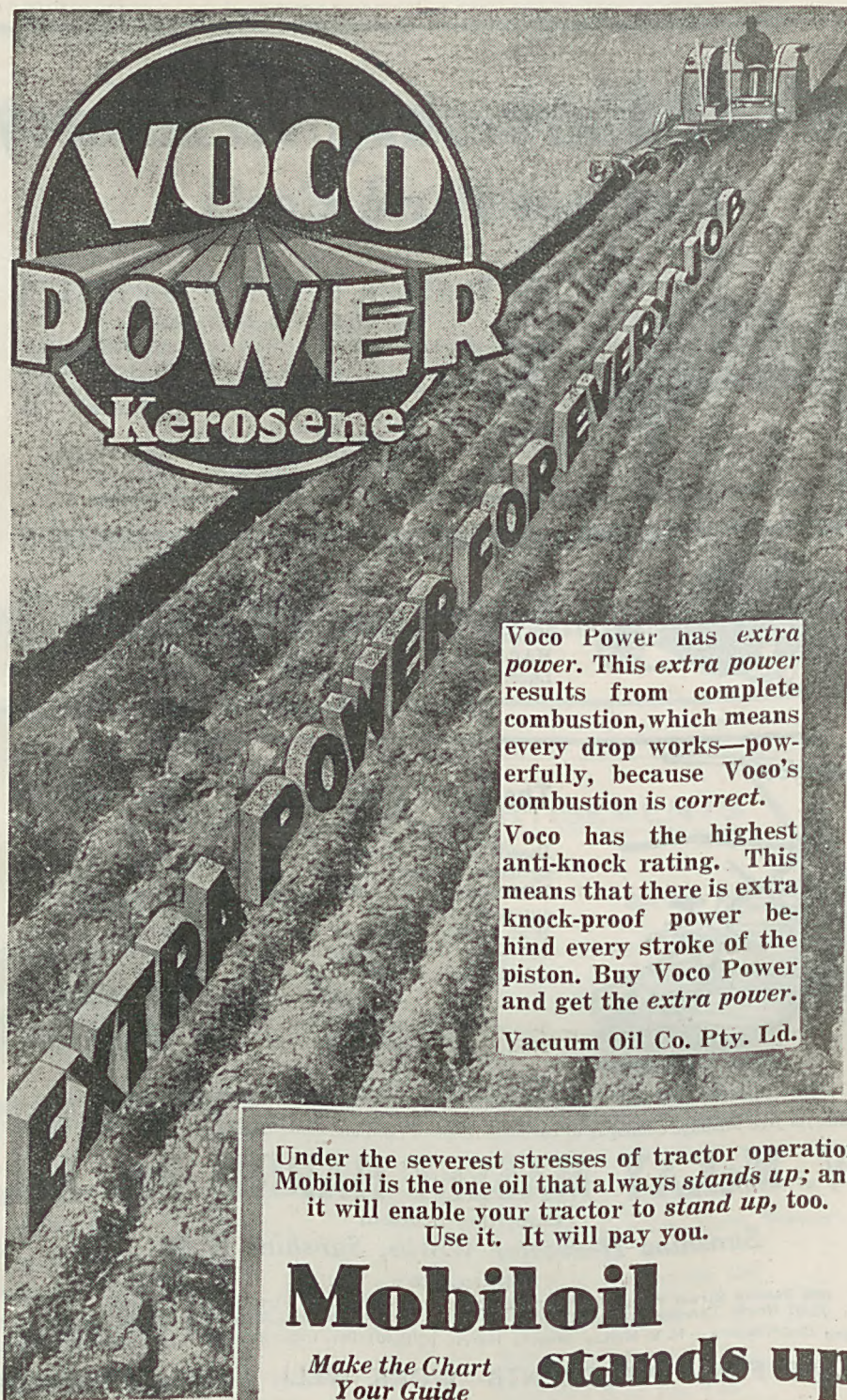
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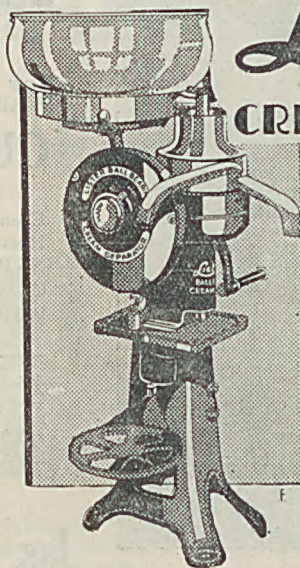
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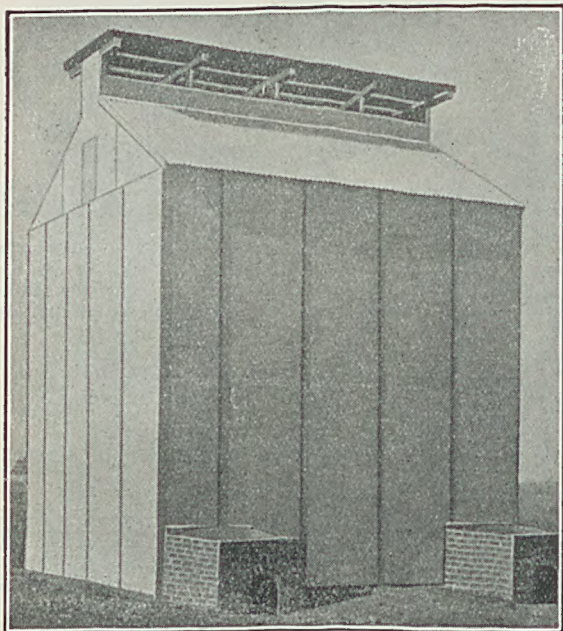
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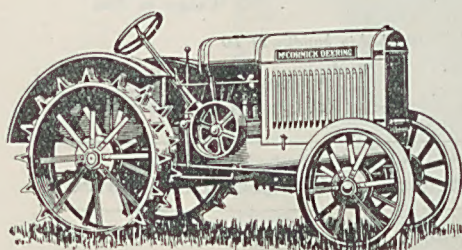
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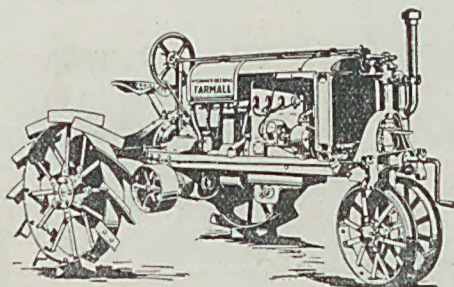
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MODEL 10-20.

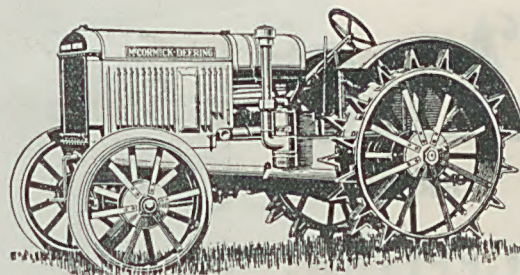
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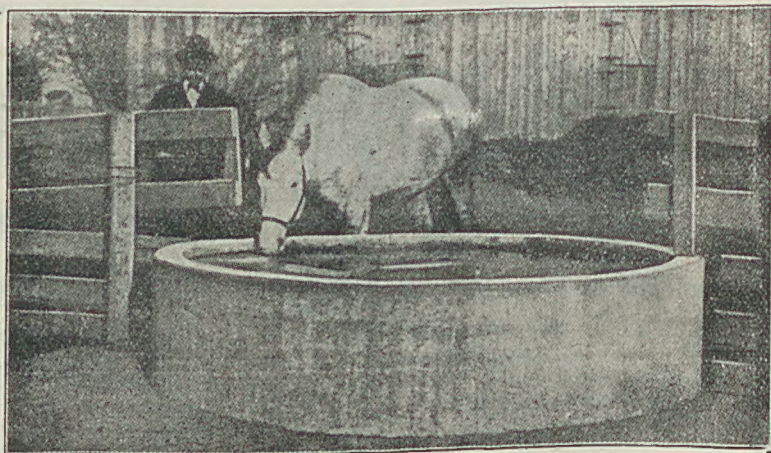
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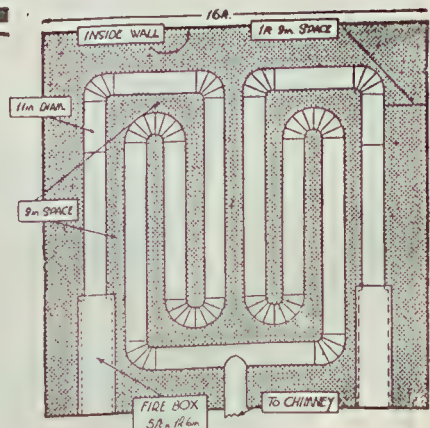


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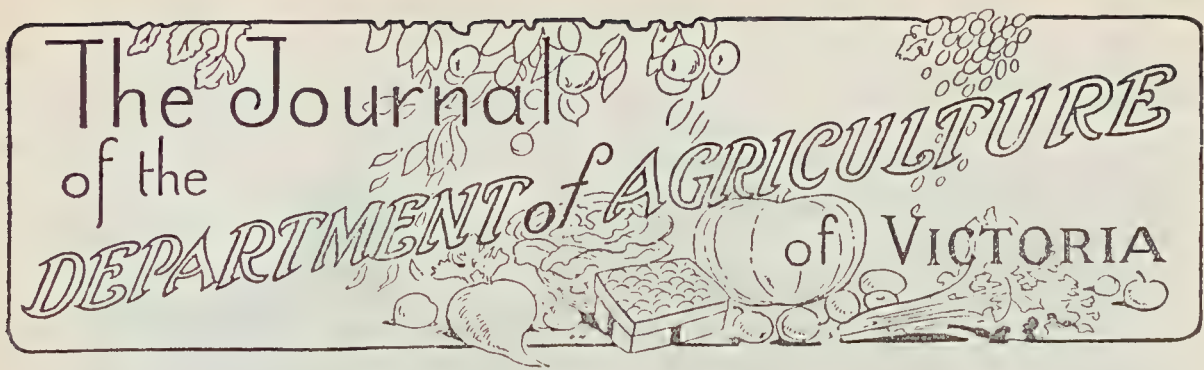
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Some Aspects of Plant Breeding

The Problem of Disease Resistance

By A. R. Raw, M.Agr.Sc., Cereal Geneticist.

TO the average person, the outstanding aim of the breeder of crop plants is so obviously to increase yield per acre that any detailed discussion of the subject might appear superfluous, yet, in reality, the objectives of the plant-breeder are not merely complex, but they change with changing conditions, both economic and cultural. Apart from the inherent multiplying power of a plant, there are other characters which affect its yielding capacity, and, of these, the most important is the capacity of the plant to multiply in the special cultural conditions under which it is grown. This involves the ability to resist disease, adverse climate, and other unfavorable conditions.

One of the major problems confronting the plant-breeder is the production, by cross-breeding and selection, of varieties of crop plants resistant to disease. Plants, like animals, are subject to the ravages of numerous disease producing organisms, which take their toll of the crops throughout the world, and are responsible for losses amounting to hundreds of millions of pounds annually. Some of these diseases are more or less easily controlled by cultural practices, or by the use of preventive measures such as spraying, or the treatment of the seed prior to sowing; but there are others in which all preventive treatment fails. It is in these cases that the use of resistant varieties is destined to play its most important role. In fact, it is now being generally

recognized, that the use of resistant varieties, even in cases where control methods are simple and effective, is the most economic method of combating the disease problem.

In the case of wheat—Australia's most important crop plant—there are three main groups of major diseases, the rusts, the smuts, and what may be loosely termed, the foot-rots. It is an unfortunate fact that, generally speaking, the most prolific varieties are the most susceptible to these diseases, of which, only two, bunt or stinking smut, and loose smut, are controllable. The only direct means of combating the remainder is by the use of resistant varieties. There are more than 3,000 different varieties of wheat known, and among these, a considerable number are specifically resistant to one or more diseases. Unfortunately, most of these resistant forms fail in other respects, such as yielding capacity, and on this account are of little or no value for direct cultivation. It has been found, however, that the character of resistance to disease is heritable, and can be transmitted from parent to offspring. This discovery has opened up a new and unlimited field of activity to the plant-breeder. By the use of these resistant varieties as parents for mating with the more prolific but susceptible types, and by judicious testing and selecting over a period of years, the desirable characters of resistance and high yielding capacity can be combined in the progeny. By this means a new series of varieties can be built up to

replace the susceptible ones at present under cultivation.

The technique of breeding for disease resistance is, of necessity, more complicated than that of breeding solely for yield characters. In the first instance, the plant-breeder must institute a methodical search for resistant parent types, and in many cases this necessitates a thorough investigation of varieties obtained from the distant corners of the earth. An example of this is furnished by the recent discovery in remote China of a wheat which has proved to be immune to the attacks of rust, a serious disease in the wheat crops of the Argentine.

Having obtained his resistant types, and having mated them with the desired prolific varieties, the breeder must now set about testing the progeny for disease resistance. In order to do this it is necessary for him to grow all his selected plants under epidemic conditions, and in nearly all cases these epidemics of the disease must be artificially produced either by inoculation of the seed or seedling with spores, or by growing the plant in soil cultures of the disease. In this way resistant strains are isolated, and these are then subjected to accurate yield trials to determine whether or not they are sufficiently prolific to replace the existing varieties under cultivation. Results are of necessity slow, since the production and testing of these new varieties



The plant-breeder at work.

requires years of careful work, and the handling and testing of hundreds of thousands of individual plants before the desired type can be obtained.

One of the first problems to be attacked was the breeding of new prolific varieties which would resist the attacks of rust, a disease which happily causes little concern to the Australian wheat-grower, except in exceptional seasons, or in limited localities such as southern Queensland and portions of New South Wales. In the older countries of the world, however, and particularly in Canada and the United States of America, the disease may, and does frequently, reach epidemic proportions; and it is here that the need for resistant varieties is most urgent. Sir Roland Biffen, working at Cambridge in 1912, was the first to discover that the character of resistance to rust was heritable, and since that time plant-breeders have been con-



Testing new crossbred wheats under field conditions.

centrating on the problem of the production of prolific rust resistant wheats. The story of their activities is indeed one of an epic struggle between the forces of science on the one hand, and those of Nature on the other. The problem is complicated by the presence of a vast number of different biologic forms of the disease, forms to all of which no single known variety is resistant, but the plant-breeder, despite disappointments and innumerable setbacks, is gradually combining the resistance to all these forms, and is slowly but surely building new varieties which will be wholly resistant to the ravages of this disease, and at the same time possess the characters of high yielding capacity, and good baking quality.

In Australia, the problem of producing rust resistant wheats is much simplified by the fact that very few biologic forms of the disease are present, and that only one of these predominates. The late William Farrer, Australia's pioneer wheat-breeder, was the first to realize the importance of breeding for disease resist-



Inheritance of resistance to Flag Smut in Wheat.

Row 1, Resistant; Rows 2 and 3, Susceptible to disease. The three selections are the progeny of a mating between Nabawa (resistant) and Indian H. (susceptible).

ance, and although his efforts were not wholly successful, they paved the way for the breeders of to-day.

Considering the second group of organisms, the smuts, we find three diseases—bunt or stinking smut, loose smut, and flag smut. Of these, the first two are controllable, the former by the dry pickling of the seed with copper carbonate, the latter by the hot water treatment of the seed. For the third and final member of this group, flag smut, there is no known method of control, and the only means of combating the ravages of this disease is by the replacement of the susceptible varieties at present under cultivation by new resistant forms.

Flag smut is prevalent in all States of the Commonwealth, and is responsible for losses amounting to hundreds of thousands of pounds annually. The fact that it fails to respond to control measures indicates that it is likely to become the bane of the Australian wheat-grower. The disease might aptly be termed the tuberculosis of the wheat plant, since it strikes at the very lungs of the plant, manifesting itself in the leaf, leaf sheaf, and stem, completely destroying the tissues, and resulting in most cases in early death. It has become such a menace to the successful cultivation of the wheat crops, that plant-breeders all over the Commonwealth are focussing their attention on the production of resistant types. Numerous varieties have been subjected to



Flag Smut of Wheat.

Plants 1 to 3, infection in early stages of growth resulting in premature death; Plant 4, very slight secondary infection (indicated by arrow).

infection tests, and the results have shown that certain of these are highly resistant to the disease. Generally speaking, these resistant forms are poor yielders, and are therefore of no value for direct cultivation. There are, however, one or two exceptions, and of these, Nabawa, a moderately prolific variety, which is highly resistant to flag smut, is outstanding. This variety was bred by the Department of Agriculture of Western Australia, and is now extensively grown in that State and in South Australia and New South Wales.

Infection tests, conducted at the State Research Farm, Werribee, and elsewhere, have indicated that another variety, Ghurka, also possesses a high degree of resistance to the disease. This variety, bred at Werribee, and now in general cultivation throughout the State, is perhaps the most promising wheat produced at the farm, and its prolificacy, coupled with its high degree of adaptability to widely varying conditions, and its resistance to flag smut, indicate that it is destined to play an important part in the agriculture of the future. Neither of these wheats, however, is wholly immune to the attacks of the flag smut organism, but there are others—all low yielders—which are immune, and of these, such types as Dan and Cedar are being used as parent forms for the production of new prolific, immune varieties.

The work of producing these new resistant varieties has been in progress at the State Research Farm, Werribee, for several years, and some very promising results are being obtained. The most valuable development to date is the establishment of the fact that resistance to the disease is transmitted from parent to offspring, and this discovery of the method of inheritance, promises greatly to facilitate the work of breeding new immune varieties. Thus it has been proved that in the progeny of a mating between a susceptible and an immune variety, approximately one plant in every four will be immune to the disease. Matings between



Many thousands of plants are studied annually.

the above-mentioned varieties, Dan and Cedar, and the more prolific but susceptible types at present under cultivation have been made, and the progeny of these are subjected annually to artificially produced epidemics of the disease. Selections which fail to contract the disease over a period of from three to five years are considered to be resistant, and are then subjected to accurate tests to determine their yielding capacity. From four to five hundred selections, involving the handling and minute examination of close on fifty thousand plants, are being tested annually, and the results of three years' investigations lead us to hope that before long a number of prolific varieties, resistant to the disease, will be available, and the flag smut menace will cease to be. Hand in hand with these investigations, attempts are being made to produce varieties which will be resistant to loose smut and to bunt or stinking smut, and although this work is still in the embryo stage, the outlook is particularly bright, since parent types resistant to both these diseases are available, and will form the basis on which new prolific, resistant varieties will be built up.

The third and final group of organisms, constituting those diseases known as the foot-rots, presents a more complicated problem, since no resistant varieties are known at the present time. However, a ray of hope is presented by the fact that varieties resistant

to allied diseases in barley have been isolated, and it is possible that before long resistant wheat varieties will be discovered among the three thousand odd wheats already known.

The possibility of building up disease resistant varieties by crossbreeding and selection is by no means confined to wheat alone. It applies equally well to all types of crop and garden plants, and the list of new varieties which are resistant to disease has already assumed notable proportions. To mention a few; we have barleys and oats resistant to rust and smut, vines resistant to mildew, asparagus resistant to rust, wilt resistant varieties of tomatoes, flax, cotton, peas, and melons, potatoes resistant to Irish blight and wart disease, and tobacco plants which will thrive in areas where root-rot is prevalent. No consideration of the problem of breeding for dis-

ease resistance in plants would be complete without some reference to the breeding of resistant varieties of sugar cane in Java. In 1880, the sugar industry in Java was threatened by the attacks of mosaic disease which destroyed the canes. As a result of careful search, wild immune types were discovered in Northern India, and these, mated with the high yielding varieties of Java, resulted in the production of new prolific forms which were immune to the attacks of the disease. This work was the salvation of the sugar industry in Java and many other sugar-growing countries where the disease was prevalent.

And so the struggle goes on, with science, assisted by nature, waging a winning fight, a fight in which each step gained may mean the saving of millions of pounds annually.

Control of Cutworms

By C. French, Junr.

AT the present period of the year, cutworms are causing severe damage to crops and pastures in the greater part of Gippsland. As the cutworm plague is capable of continuing and causing considerable damage until the end of February (providing weather conditions are suitable), it is necessary that precautions be taken to prevent the further spread of these pests. Whilst one farmer in a district can accomplish much towards the control of the cutworm in his own property, the extermination of these pests from a district requires an effort on the part of the whole community.

The following methods are suggested as being suitable for the control of the pests, some, of course, being particularly suitable to one district, whilst others are more suitable for other districts. The ploughing of the land early in the autumn, just previous to sowing the seed, will expose many of the chrysalids remaining from the previous summer, with their resultant destruction. The eradication of weeds and the burning of haulms and stems of harvested crops will destroy many of the eggs of these moths. Growing crops can be treated in one of two ways:—

- (a) Place between rows of an infested crop (e.g., maize, beans,) at short intervals apart, bundles of any succulent weed or vegetable which have been previously poisoned by dipping in a strong mixture of

Paris green, 1 oz. to a bucket of water. The cutworms eat the poisoned baits, bury themselves and die. In hot weather the bundles should be put out after sundown.

- (b) The use of poison bran baits is strongly recommended. These are made up in the following proportions—Bran 10 lb., Molasses 4 lb., Arsenate of Calcium 1 lb. The bran and the arsenate of calcium are mixed in a dry state, and then the molasses diluted with water is added, until the whole mass becomes very slightly sodden. This material is then broadcast or placed in small pieces (about the size of a walnut) in the infested areas. In hot weather, this also should be placed out after sundown.

The trench system is another simple yet effective method of eradication. A trench or furrow should be ploughed or dug around the crop towards which the cutworms are feeding. It must have clear cut sides; those nearest to the crop should be undercut so as to prevent the cutworms from crawling out of the trench. Deep holes should be made in the trench at intervals of, say, five yards. When travelling towards the crop the cutworms fall into and crawl along the trench and ultimately into the holes. The holes can then be rammed and the grubs destroyed.



Budding Citrus Trees

Methods Described

By J. L. Provan, B.Agr.Sc., Horticultural Research Officer.

ON the subject of budding, there are perhaps more theories and ideas expressed, than on any other single operation in the citrus grove. While some of these ideas are relatively unimportant, and largely a matter of individual preference, others are technically unsound and should not be considered. There should be no guesswork about budding, and if suitable conditions are observed, failures will be few. The suggestions in this article are offered to the grower who requires to bud a few trees in his grove, and not to the experienced propagator who has already attained proficiency in the practice. As well as describing the method adopted in budding, a few of the common causes for buds failing will be suggested.

In recent years there has been a growing interest in re-working old and unprofitable trees to more profitable varieties, and a very earnest endeavour on the part of the citrus grower to improve the quality of his production by the careful selection of buds from the best trees.

Many citrus growers have cut back orange and lemon trees which were bearing inferior quality fruit, and varieties which were no longer profitable, with the object of re-working them in the approaching autumn. In addition, some growers have wild lemon stocks which they are desirous of budding to a profitable variety, thereby reducing the number of unprofitable trees in their groves. This is one of the means by which the citrus grower is reducing his costs of production, and increasing the efficiency of his grove. It should be the aim of every grower to make every tree in his grove an economic unit.

The trees which will be ready for budding in the autumn were beheaded severely last spring. This means that about three-quarters of the top was removed as far back as the main branching system. The result of such severe pruning forced into growth many latent buds, and these have grown during spring and summer, and produced strong vertical growths in which it is proposed to insert buds. This growth is called the stock.

Three things are required for the budding operation; suitable bud-wood, a sharp knife and material for binding.

Time of Budding.

Budding of citrus can be successfully accomplished only when the sap in the buds and the stock is moving freely. It is useless to attempt budding when the trees are not in this condition. Usually the best months for budding are November and March. The presence of six to seven inches of new growth on the tree, and the fact that the bark easily separates from the wood, serve as good indications of the free movement of the sap and the presence of new growth in the cambial region. When budding, choose a clear, warm day, and avoid excessively hot and windy weather. The spring buds (November) will commence growing in early December, but budding done in the autumn remains dormant during the winter, and commences growth the following spring. Personally, I prefer autumn budding, which has the additional advantage that failures can be re-budded in the spring without loss of time.

Choosing the Buds.

The choice of buds is the next and very important consideration. Trees which are to supply buds should be healthy, vigorous, and consistently produce heavy crops of good quality fruit of the desired variety. Any trees which show signs of pronounced variation in quality of the fruit or any indications of "sporting," should not be chosen as parent trees. Having decided upon the particular trees, the next step is to select suitable bud-wood from shoots on these trees. Disregard suckers and watershoots, thorny wood and immature growths. While watershoots have actually the same inherent constitution as the remainder of the tree, it has been found that these buds have more tendency to "sport" than buds from normal growth.

The term "bud-wood" is used to denote the short twigs, carrying the buds, cut from the tree. The bud itself could be cut singly from the tree, but it is more convenient to remove the whole twig with a number of buds. Bud-wood should be chosen from well rounded, mature wood about the thickness of a pencil and not more than one-year old. Young and

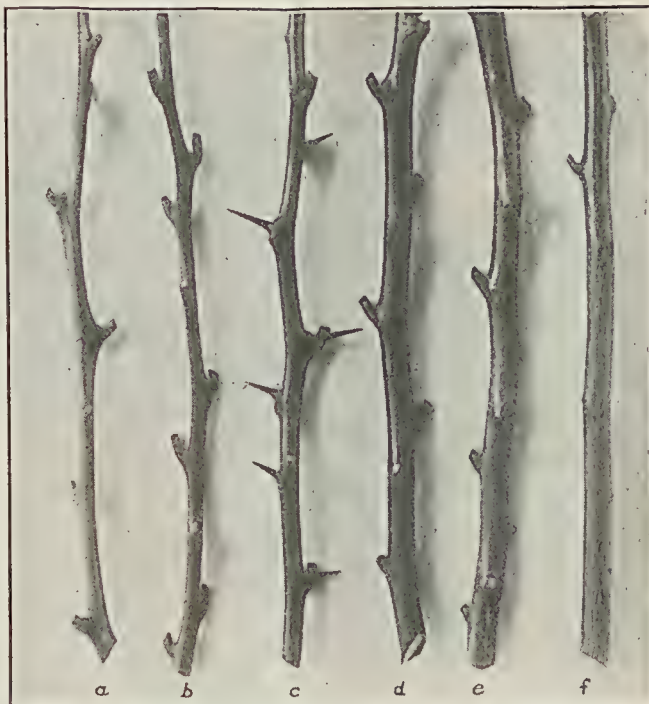


Fig. 1.—Suitable and Unsuitable Bud-wood.

Unsuitable—*a* and *b*, young angular wood; *c*, thorny buds; and *f*, wood too old and buds becoming "blind".
Suitable—*d* and *e*, well rounded, mature wood with plump, vigorous buds.

immature wood of orange and lemon trees is angular and of a light-green colour, but as maturity is approaching, it becomes rounded and dark-green. When nearly mature, the bark becomes somewhat rough and streaked with irregular grey patches, and finally turns a greyish-brown. When the wood has attained the dark-green colour and has become well rounded, it is suitable for the supply of buds. I cannot advise growers with a limited experience of budding to attempt the use of angular wood. A good plan is to take into consideration the relative sizes of the bud and stock; budding a large vigorous shoot with a large bud from a thicker piece of bud-wood. When the bud-wood is taken from the tree it is usually cut into suitable lengths for handling—eight to ten inches long, and the leaves are removed by cutting through the middle of the petiole or leaf stalk. A short piece of stalk then remains attached to near the bud, this being very helpful in its subsequent handling. (See Fig. 1.)

If the bud-wood is not required immediately, or if it has to be transported any distance, it should be packed in damp sphagnum moss or

damp newspaper and placed in a cool spot. It is a good plan to wrap the bud-wood in a wet sack during budding operations. All care should be taken to avoid any drying which will lessen the vitality of the buds.

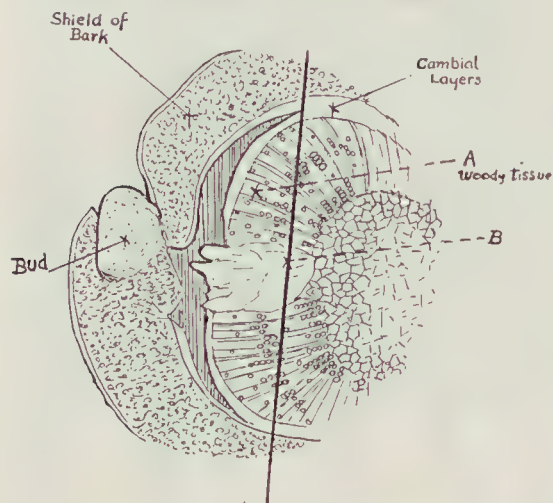


Fig. 2.—Transverse, microscopical section of portion of a bud-stick in the region of the bud, showing splitting of cambial layers.

The knife cut made when removing bud is shown by the line B, and portion of the woody tissue which remains attached to the bud and which should be removed before placing in the stock is seen at A.

(Magnified about 40 times.)

Fundamental Principles of Budding.

Let us digress for a moment and in a few words explain why it is possible to cut a bud from one tree and place it in another, so that it unites and grows.

Between the bark and the wood of fruit trees is a thin layer of brick-shaped cells which are capable of growing and increasing in number by division. This layer is called the cambium. It is only because of these young growing cells that the budding operation becomes possible.

When the tree is growing freely, or in other words, when the sap is rising, the bark separates readily from the wood. This separation is possible because the zone of active growth in the cambial region is a weak area; the cells not having had time to become thickened and strengthened. This splitting is clearly illustrated in Fig. 2. When the bud is separated from the wood, portion of this cambial layer remains attached to the wood, and portion to the bud and shield of bark.

The object in budding is to place the young growing cells on the inside surface of the bark

of the bud against similar cells on the wood of the shoot to be budded, i.e., the stock. Then excluding as much air as possible to prevent excessive drying, conditions are favorable for a union to take place, and the bud is joined to the wood by a new growth of these cambial cells.

The Budding Operation.

The Stock.—A good plan is to remove any leaves and thorns near the base of the shoot, so that they will not interfere with the operation. Then choose the side of the shoot which is nicely rounded and is sheltered from the hot afternoon sun, and near the base make an incision with the point of the budding knife in the bark, slightly more than an inch long and deep enough to cut the bark. The knife is then turned at right angles to this cut, and another cut is made across the bottom of this incision. The shape of the cut now resembles an inverted T. Some budders prefer to make the horizontal cut across the top, the cuts then resembling a normal T shape. This is largely a matter of use and individual preference. I consider, however, that the inverted T cut is to be preferred when there is a risk of heavy rain following upon the budding operation. The inverted T cut will shed



Fig. 3.—Stages in the Budding operation —(a) the prepared stock; (b) bud inserted; and (c) bud tied with raffia.

water should it penetrate the binding material. The presence of water under the flaps of bark, or under the bud, is fatal to its success.

The knife blade is then inserted in the vertical cut near the junction of the two cuts, and the flaps of bark are separated carefully from the wood by raising gently. It is essential that care be exercised in this operation, otherwise the delicate cambial cells on the surface of the exposed wood will be injured. The shoot or stock is now ready to receive the bud (Fig. 3).

Cutting the Bud.—In cutting the buds from the bud-stick, growers who have had only a limited amount of experience will be well advised to use only plump, vigorous buds. If the small, almost dormant looking buds are used, difficulty is often experienced in forcing the buds into growth, even after they have successfully healed to the wood of the stock. On this account buds which appear to be "blind," i.e., those generally near the base of a shoot, should be discarded.

The next step in the budding operation is to remove the bud together with a shield-shaped piece of bark from the bud-stick. The term shield-budding is given to this method from the appearance of the piece of bark containing the bud removed from the bud-stick

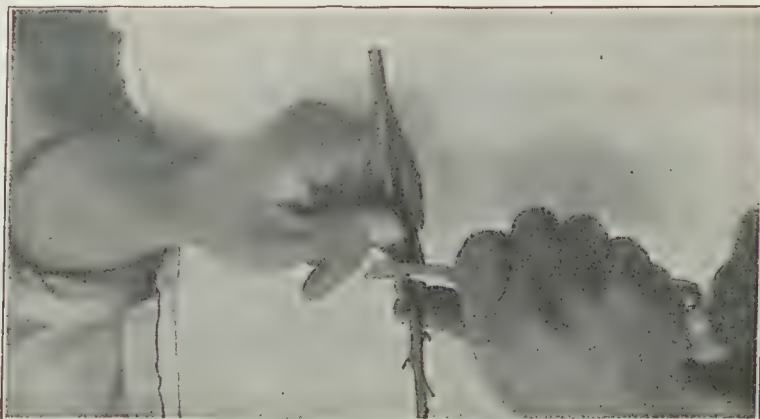


Fig. 5.—Removing a bud from a bud-stick—as it appears to the budder.

(Fig. 4). This is accomplished by a thin slicing cut commencing about half an inch above the bud and finishing about half an inch below. It is customary to hold the bud-stick in an inverted position while cutting this bud, so that actually the cut commences from below the bud and comes to the surface again above the bud (Fig. 5). The cut is made as shallow as possible, but usually a piece of wood also is cut from the bud-stick. This will adhere to the bud and can be readily seen on examination (Fig. 4). It is a good practice to remove this piece of wood, which can be easily done by slight pressure on either side of the bud and a gentle lifting motion with the thumb nail. If the buds are in good condition, the wood separates readily. By removing this piece of wood, the chances of the bud uniting are greatly increased, because the area of the cambium region on the bark of the bud is totally exposed (Fig. 4), and can be placed against the cambium region of the wood of the stock. Some budders prefer to leave the wood in the bud, but it can be quickly seen that this reduces the surfaces of the growing areas. Care is necessary in removing the wood from the bud to prevent any creasing or other damage to the small bud itself. Sometimes it is found that, while the shield of bark remains green and has united with the stock, the point or eye of the bud has turned brown and died, and therefore no growth is possible. This is due to an injury caused by rough handling of the bud.



Fig. 4.—Buds cut from the bud-stick.

a and *b*, front view of suitable buds; *c*, rear view showing woody tissue and small margin of cambial layer; *d*, rear view showing wood (*e*) removed and exposed cambial layer.

Holding the bud by the small piece of leaf stalk, it is carefully pushed up into position beneath the two flaps of bark on the stock, and

these two flaps then close over it (Fig. 3b). Gently press the bud against the stock.

Tying or Binding.—The next operation is to securely tie the flaps into place and exclude as much air as possible from the bud. For this purpose natural raffia, or prepared waxed tape can be used. Substances of an oily nature should not be employed as they are generally fatal to plant life. Natural raffia which has been wrapped in a damp bag overnight—but not actually watered—will be found pliable and strong. A good practice is to give the raffia a stretching prior to use. If wet raffia is used it will be found that on drying, the binding has become loose, probably with fatal results to the bud. Coloured raffia does not appear to be suitable for binding; the dyes used in its manufacture being harmful to the citrus tissue under some conditions.

The entire cut is covered as neatly as possible with the exception of the eye of the bud itself. If the raffia is drawn tightly across the eye of the bud, it will often damage it and the bud will fail. The tie should be firm but not tight enough to cut or bruise the bark (Fig. 3c). When budding, work as rapidly as possible to minimise the risk of the exposed cambium cells becoming dry.

WAXED TAPE.

Many propagators prefer to use narrow strips of muslin, soaked in a wax mixture, for binding material. The advantages of the waxed tape are that it is impervious to air and moisture, thus preventing the bud from drying and rain from entering the wound, and in addition it does not require tying. When binding the bud with waxed tape, commence at the bottom so that the folds will overlap and assist in shedding rain.

Various formulae are used in preparing this waxed tape. One which is simple and requires ingredients readily obtainable, is made by dipping strips of calico or muslin in a melted mixture of two parts of beeswax and one part of resin. The strips should be 2 or 3 feet long and 10 to 12 inches wide. They are placed into the melted wax and allowed to become thoroughly saturated. The superfluous wax is removed by drawing and squeezing the cloth, while still hot, between two sticks. Strips $\frac{1}{4}$ in. to $\frac{1}{2}$ in. wide and 10 to 12 inches long, can then be conveniently torn from the pieces as required. For convenience in the grove, the waxed pieces are wound round one

end of a stick, the other end of which can be pushed into the soil when budding.

Inspection of Buds.

In 10 to 12 days' time the buds can be examined, and if still green, they have been successful. If the eye of the bud has become a brownish colour and the shield of bark is still green, then the bud will not grow. Sometimes in pushing the bud into position under the two flaps of the bark of the stock, the sharp edges cut the eye of the bud. This injury may be sufficient to cause it to die, while the shield remains green and unites with the wood. In some cases the shield is observed to die either below or above the eye of the bud. These buds however, generally will grow, and later the new callus will form over the dead area.

Three weeks after budding the binding can be removed. In the case of re-worked trees, a good plan is to make a loose tie around the base of the budded shoot. This will serve to indicate where the bud has been inserted, because in a few years' time it becomes difficult to distinguish between growth from the stock and growth from the bud, unless some such marking device is used.



Fig. 6.—Showing position of insertion of bud, growth of bud, topping of stock to force bud into growth, tying bud growth for support, and pruning of growth resulting in branching.

Forcing the Buds into Growth.

The buds have been inserted at the base of a long shoot, and, usually in this position they do not commence growth unless a strong sap flow is diverted to them.

Various methods have been used to "force" the buds into growth. One method consists in cutting a deep notch about 2 inches above the bud, while another removes a complete girdle of bark an inch or so above the bud. In some countries the practice is adopted of partially cutting through the stem about 2 inches above the bud and then bending the stock over, so that only a small strip of bark continues to feed the broken stock.

The removal of the stock about 4 inches to 6 inches above the newly inserted bud, has been found to give good results in Victoria (Fig. 6). The short piece of remaining stock will act as a support to which the young growth of the bud can be tied. Where difficulty is found in forcing the bud into growth, the entire stock should be removed just above the bud, making a sloping cut to facilitate healing. If this practice is resorted to, it will be necessary to support the young growth by means of stakes attached to the main branches of the tree.

With autumn budding, the removal of the top portion of the stock should be done in the spring, after danger from frosts is passed; but with spring budding, the tops can be removed as soon as the binds are cut.

The buds on the stock, apart from the newly inserted bud, will also burst into growth. These must now be considered as suckers and should be rubbed off while still small. This will be a fairly constant operation every two or three weeks, until the bud has made vigorous growth. The new growth from the bud is very brittle and liable to be blown off, and therefore it should be supported by tying it either to the

small stub left when removing the top of the stock or to a stake.

When the bud has made about 18 inches of growth, it should be shortened back to about 12 inches (Fig. 6). This will strengthen the union between bud and stock, and also form a system of branching fairly low in the tree. If this operation is neglected, the bud growth becomes top heavy and liable to break away from the stock.

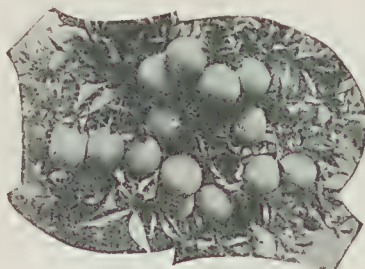
Subsequently the small piece of stock can be removed when the union is strong. A good plan is to postpone the removal of this stub until the following autumn. A sloping cut should be made as previously described.

Budding into Old Wood.

Occasionally, one hears of the success achieved by a few enthusiasts who persevere with buds placed in the old branches of an orange tree. This method is perfectly sound, but far less successful than that described above. The bark of these old limbs is very thick and difficult to handle, while frequently the new callus forms so soon and at such a rate, that it covers the bud before it can be forced into growth.

Cost of Budding

The cost of budding old trees to new types and varieties is hard to estimate, because so much depends on the condition of the trees. Where growers have to employ a local man to perform the budding, I would suggest that he should be paid at the rate of one penny per successful bud for a large number of buds, and 1½d. for smaller numbers. The cost of buds should be about ten shillings per hundred, while natural raffia costs 2s. 6d. per lb., which is sufficient to do approximately four hundred buds. Depending on the size of the tree, from four to eight buds on each tree should be used.





Establishing Mixed Pastures

Preparations for Autumn Sowing

By E. D. Cameron, B.Agr.Sc., Assistant Agrostologist.

IN recent years permanent pastures have justifiably assumed an important role on the farm and, more particularly, on the dairy farm. Production from pastures is the main source of exportable products, whether they be wool, meat, or dairy produce. Dairy exports in particular have served Australia well during the trade depression period, and will always be a reliable standby. The 26,000,000 acres under pasture in 1929-30 yielded primary produce to the value of just over £23,000,000, while, in the same year, £9,000,000 was derived from 8,000,000 acres of agricultural land devoted to cropping. These approximate figures illustrate the important part pastures play in our national welfare.

To the farmer located in the higher rainfall areas of the State, the possession of fields which can carry stock for twelve months of the year is of paramount importance. An even and uniform production which can be obtained only with these pasture conditions is much more profitable than a production subject to acute and periodic rises and falls.

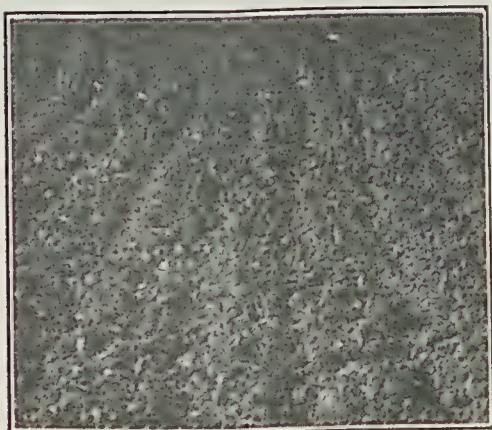
In the wheat growing and lower rainfall areas, annual pastures, supplemented by the growing of some summer fodder crop such as lucerne, maize or millet, have of necessity to play a greater part.

In the intermediate zones, intermediate pasture consisting of both annual and perennial plants may be established. Under a moderate rainfall of, say, 24 or 25 inches, a mixture

consisting mainly of perennials is advised, whereas in areas not quite so favorably located annual plants must form the major portion of the annual-perennial pasture mixture.

In seeding land to either permanent or annual pasture, the first point to be considered is that of soil preparation. Some farmers still consider that this phase of pasture establishment is of minor importance, with the result that many pastures fail in their initial stages through poor germination of the seed and through weed growth and other adverse factors, which can be traced back to unfavorable soil conditions at the time of sowing.

The methods adopted in attaining a fine, firm and clean seed bed, vary according to



Soil preparation is important.

whether the sowing is to be made in the autumn or spring. At present, it is proposed to deal with the former only. For autumn sowings, there are several methods of seed bed preparation. Firstly, a short bare fallow period may be obtained by plowing in the late spring or early summer with subsequent cultivations. Such cultivations will destroy successive crops of seedlings of annual weeds, thereby ensuring a clean seed bed free from weeds and weed seeds. At the same time, the soil will be reduced to a fine condition conducive to the maximum germination and development of the small grass seeds.

When "new" land is to be sown down, it is advisable to crop the area for a year or two before sowing a pasture mixture. Not only does the artificial fertilizing practised during this period put the land into good heart, but the cultivations required in the growth of

such crops also breaks the soil down into a fine condition, suitable for grass growth. In the case of land that has been under rotational cropping for some time and has been sown to a crop of oats, millet, or potatoes in the previous year, it is necessary only to cultivate with a spring tooth and light harrows to work to a fine, firm but shallow seed bed.

A fourth method of sowing down a pasture is to put the seed mixture in with a light cover crop to be fed off with sheep. This method has the advantage, apart from the extra feed produced, of protecting the young seedlings against wind, and the extremes of heat and cold; while in addition the soil is compacted by the tramping of the sheep and so made more amenable to plant growth. The compacting of the soil is a factor in pasture establishment which should not be overlooked. Many of the best pasture plants are fine leaved and fine rooted and cannot obtain a reliable foothold in loose soil. For this reason it is advisable where the soil conditions are suitable to roll the area thoroughly after sowing.

The next point of importance in the sowing down of any field is to decide just what pasture plants are to be sown. This will depend on three main considerations.

First of these is the rainfall—its amount and seasonal distribution. All species require a certain minimum rainfall if maximum growth is to be obtained. For instance it would be unwise to sow white clover on an area with a 20-inch rainfall, because experience has shown that this plant requires some 30 inches of annual precipitation. Similarly, a winter rainfall will support only winter and spring growers, while a summer rainfall makes the introduction of summer growing species possible. A mixture of both winter and summer grasses requires a good rainfall evenly distributed throughout the year.

Secondly, consideration of the soil type will be necessary to determine its suitability to support particular species. A heavy soil is best suited to the development of such plants as white clover and perennial rye-grass, while subterranean clover prefers a lighter and more friable soil.

Thirdly, the pasture requirements of the farm, to a certain extent, will determine the pasture plants to be sown. If winter feed is required then winter growing species such as *Phalaris tuberosa* and subterranean clover, must be sown. On the other hand, summer growers may be needed, in which case special

species, such as cocksfoot, paspalum, and strawberry clover, should be selected. If "all-the-year-round" grazing is desired, a balanced mixture of both summer and winter growers will be necessary.

Having decided on the species to be sown, a further matter of great importance presents itself—that of the selection of suitable strains or varieties. Undoubtedly, many failures in pasture establishment in the past have been due to the sowing down of unsuitable strains. In the case of perennial rye-grass, it has been believed that any New Zealand rye-grass is reliable, but such is not the case. Trials conducted by the Agrostology Branch of the Department of Agriculture at the Pasture Plant Research Station at Burnley, have shown that only the Government certified seed of New Zealand is worth-while. The bulk of New Zealand imports consist of short-lived types which disappear in the second or third year and give place to weeds. Similarly, other foreign imports cannot be relied upon to give the best results under our particular climatic conditions. Seed harvested from old pasture stands in the Western District of Victoria, however, will give a satisfactory and perennial stand if bought with care and discrimination.

Investigational work at Burnley has shown Victorian cocksfoot to be equal to and in many cases superior to imported lots. Danish cocksfoot is stemmy and hard, while the best Victorian strains are leafier and more palatable to stock. The New Zealand Akaroa cocksfoot occupies a position mid-way between these two extremes.

White clover strains also have been subjected to trials. In this case too, the Victorian strains have stood the test, but, unfortunately, no white clover seed is harvested in Victoria, with the result that we have to rely on imports of this seed. There is every reason to believe, however, that, for our conditions, some of the strains being segregated at Burnley will prove to be equal to any of the imported strains.

Of the imports, New Zealand certified white clover appears to be the best. It is a highly productive and vigorous plant capable of withstanding hard grazing. The White Dutch and New Zealand ordinary types are loose growing and contain a fairly high proportion of short-lived types. Kentish wild white



A good permanent pasture mixture with perennial rye-grass, cocksfoot, and white clover predominating.

clover is a small plant, a fairly low producer and apparently unsuited to dairy pastures.

Although many suitable strains of subterranean clover have been isolated they have not yet been developed on a commercial scale. The subterranean clover of commerce is, however, a good mid-season strain.

It should be emphasized that many failures in sowing down pastures are due to unreliable seeds, so that it behoves the farmer to make his purchases carefully. Good seed doubtless will cost more money, but it is more economical to increase the initial outlay on a 10 to 20 years' investment than to spend less on seed which will be persistent for a year or two only.

Another important matter requiring consideration is that of time of sowing. This will depend on past experience and seasonal conditions, but, as a general rule, sowings just after first autumn rains will be satisfactory in germination and subsequent growth. If sown at this time, the young plants have a chance to become well established before the cold winter weather retards growth, and there is less likelihood of their being smothered by winter-growing weeds. In the Gippsland and Beech Forest areas, early to mid-season sowings have proved satisfactory, while in the Western parts of Victoria mid to late autumn sowings usually have given the best results.

Let us consider now the methods of sowing. As already mentioned, the first essential must

[Continued on page 70.]

The Sheep Industry

Helpful Hints to Sheep-men

8.—Liver Fluke Disease.

By W. D. Shew, B.V.Sc., Veterinary Officer.

[Previous articles of this series, which appeared in the June, July, August, September, November, and December, 1932, and January, 1933, issues of the Journal, dealt with the selection of ewes and rams, lamb marking, classing the wool clip, fat lamb raising, the sheep blowfly, foot-rot, and worms.]

LIVER Fluke Disease is one of the most serious diseases of sheep in Australia.

In addition to the actual mortality from the disease, the great deterioration in wool and mutton value of those animals which survive attacks must be taken into consideration. Further, it is now known that an invasion of young flukes renders sheep susceptible to that deadly infection, known as *necrotic hepatitis*, or Black Disease. It is found, also, that fluke-infested sheep are more susceptible to infection with other parasites, such as stomach, intestinal and lung worms. In view of all this, it is not surprising that once a property is looked upon as "fluky," its value deteriorates considerably, and sheep from such a run are not sought after by buyers so eagerly as are those from clean country. In addition to sheep, cattle also are liable to infestation by Liver Fluke.

Distribution and Economic Importance.

Liver fluke invasion is most prevalent in Australia, in those districts having a comparatively heavy rainfall, such as high undulating tablelands, lake districts, flat coastal country, and also irrigation areas. Severe annual losses are reported from New South Wales, South Australia, Tasmania and Victoria.

In Victoria, it has been found that the North-Eastern and Goulburn Valley districts and a portion of the North-West are especially prone to this disease. It is also fairly prevalent in certain parts of Gippsland and the Western District. In the other States, also, there are certain areas where losses are particularly severe.

As the disease can be prevented, and even when present can be eradicated, it is a lamentable fact that it should still be permitted to exact such a toll from our stock-owners.

The Life Cycle.

Liver Fluke Disease is caused by a flat, leaf-like, somewhat oval worm, known as the liver fluke (*Fasciola hepatica*), which is found in the bile ducts and liver substance of sheep and also of cattle. It is yellowish or grey-green in colour and is about 1 inch long by $\frac{1}{2}$ inch wide. (Fig. 1.)

It is essential that stock-owners should understand the life history of this parasite in order that they may appreciate how stock become infested, and how the disease can be prevented, or, if stock and the pastures are already infested, how the parasite may be eradicated.



Fig. 1.—Adult Fluke.

Adult fluke may be found in large numbers in the bile ducts of the liver, and here they lay their eggs. Each fluke is capable of producing many thousands of these minute brownish-yellow, typically egg-shaped objects, which may be seen by smearing a little bile from the affected ducts on a piece of glass and holding this up to the light. From the liver these eggs pass into the bowels, and then, with the faeces, are deposited on the pastures. Fluke eggs will not hatch unless they soon come in contact with moisture, in which case they will hatch out in warm weather in about 11 days; but, under cooler conditions, they require a

longer period. A minute fluke (Fig. 2) is formed within the egg,* and its active movements gradually push up a small lid at the top of the egg, and hatching is completed by this microscopic fluke emerging. It is covered with fine hairs by means of which it swims about rapidly, but will live for a few hours only unless it comes in contact with a certain variety of small fresh water snail, which is essential to its further development. This snail will be described later. On finding this snail, the tiny fluke bores its way in, and undergoes a complicated course of development. Some few months later, growth within the snail is completed, and for each tiny fluke which entered the snail, some hundred or more young ones may emerge. These young flukes, still microscopic in size, are heart-shaped, and have long tails (Fig. 3).

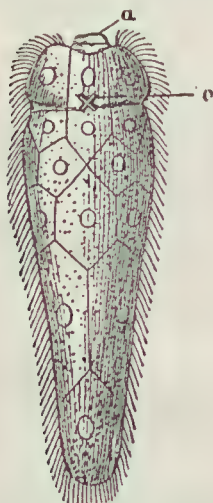


Fig. 2.—Young Fluke (enlarged).
a—perforating apparatus;
o—ocular spot.



Fig. 3.—Young Fluke (greatly enlarged).

For a short time they swim about in water, and then attach themselves to weeds or blades of grass. Their tails disappear, and a secretion is thrown off, forming a protective cyst-wall around them. These encysted forms are now ready to infest sheep, and the only way in which sheep can become infested is by drinking water containing flukes, or by grazing on affected pastures.

In the sheep, the cyst-wall is dissolved by the digestive juices, the tiny fluke bores through the bowel-wall, and falls into the abdominal cavity, i.e., outside the bowel-wall, where, in a few days, it increases in size, and

when about one-eighth of an inch in length, and resembling an adult fluke in appearance, it attacks the liver, bores its way in, and so through the liver substance, and making its way to the bile ducts, completes its life history. It becomes mature in the bile ducts, and about two months later will lay thousands of eggs.

Symptoms.

Affected sheep, if driven, will be noticed to be languid and easily fatigued. If examined, the membranes of eyes and mouth will be seen to be anaemic. Later their gait may become stiff; they will lose condition rather rapidly, and dropsical swellings may develop under jaws, chest, and along the abdomen. Death may take place within two or three months, or the animals may apparently recover, but even in these cases the interference with growth and loss of condition is very serious. The carcass of a sheep which has died from fluke disease will be emaciated, generally there will be fluid in the abdominal cavity, whilst the liver will be found to be much altered, the bile ducts thick and distended, and on opening these, large numbers of fluke will be revealed. Fluke may live in the bile ducts for twelve months or more.

Treatment.

Treatment of this disease proved unsatisfactory until 1926. In that year, R. F. Montgomerie, B.Sc., P.H.D., F.R.C.V.S., working in Wales, found that one dose of carbon tetrachloride was definitely effective in destroying all adult flukes in an infested sheep. Carbon tetrachloride is a heavy colourless liquid with a characteristic odour, and is very volatile, that is, it will evaporate quickly. The cost of this drug is small, and it can be easily administered. For each sheep, the dose is one cubic centimetre, or about sixteen drops. This is a perfectly safe dose, and is quite effective in destroying all adult fluke.

There are two methods of administering the dose in regular use:—(1) The liquid method; (2) the capsule method.

If using the liquid method, one must first dilute the drug with liquid paraffin so as to make a larger bulk, which can be easily given through the mouth with a syringe. To prepare the mixture add 4 parts of liquid paraffin, an oily colourless liquid, to 1 part of carbon tetrachloride. For one dose, 1 c.c. of carbon tetrachloride is required, to which must be added 4 c.c. of liquid paraffin, making a total dose

of 5 c.c. A special 5 c.c. syringe, with a metal nozzle, suitable for administering this dose, may be purchased. If desired, the mixture can be purchased ready for use.

Any druggist will supply the drug, the paraffin, and the syringe. One quart of carbon tetrachloride and 4 quarts of liquid paraffin will be sufficient to drench every 1,000 sheep. Only sufficient for immediate use should be prepared. While the mixture is being used, it must be kept securely corked, for the drug is so volatile that much of its strength may be lost by evaporation if exposed to the air.

The capsules are like small lozenges, and can be purchased from any chemist or drug store, filled ready for use. In some ways this method is to be preferred, as the dose does not have to be measured, and there is no loss by evaporation. However, there are certain drawbacks to capsules, for if they are crushed by the teeth, trouble may ensue. Further, it may happen that, in some cases, they may not be swallowed, and may drop from the mouth unseen by the operator. The capsules may be given by means of a small balling gun or tube which can be made out of a piece of hose about 10 inches long, with a diameter of half an inch; insert into this piece of wood or cane not quite the length of the tubes, so as not to injure the sheep's throat. A pair of tongs made out of fencing wire is used by some owners to drop the capsules at the back of the tongue.

The price of the capsules is about 10s. per hundred, while, with the liquid method, the cost will be about 6d. per 25 sheep.

The best time to dose the sheep is about the end of May, when the flukes have mostly reached their adult stage, and are in the bile ducts. One dose should be effective; but with a view to catching any which, at the time of the first dose, had not reached the ducts, it is

advisable to give a second some six weeks later, i.e., about the beginning of July.

Such treatment, properly carried out, will eradicate the adult fluke from infested sheep, but it will not clear up fluke-infested country. This can be done only if proper measures are systematically carried out. The first essential is the removal of the small conical fresh water snail already referred to. This snail has a small greenish-brown conical shell about a quarter of an inch long. When placed with the open end of the shell downwards, it will be noticed that the spiral or curl of the shell turns to the right (*Limnea brazieri*) (Fig. 4). This is the only snail that as yet is definitely known to be the carrier of fluke disease in Australia. By destroying it, we can definitely remove the menace of the disease, for the presence of the snail is essential for the completion of the life cycle of all fluke.

It has been found that by the systematic use of copper sulphate (bluestone) the snail can be destroyed. This is best carried out by the regular broadcasting of finely powdered bluestone mixed with four parts of fine sand.

Take, say, 25 lb. of fresh bluestone crystals, and by the use of a hammer, followed by a small hand-grinding machine, crush them into a fine flour-like powder. Probably half a day would be required to do this job properly. (Powdered bluestone may now be purchased ready for use). Mix this 25 lb. of fine powder with 100 lb. of superphosphate or of fine sand, thus making 125 lb. of mixture, which is sufficient to thoroughly treat 1 acre of snail infested pasture. In actual use, one sprinkles the powder only around swampy areas, around the edges of pools, dams, &c., that is, wherever there is moisture, and consequently where snails are likely to congregate. The faintest trace of bluestone, even one part in a million, will destroy them. In addition to broadcasting this mixture, it is advisable to hang small bags of bluestone on sticks in all dams, ponds, streams, &c., to which sheep may have access.

The broadcasting should be carried out from October onwards, as the principal escape of young fluke from snails takes place from then till late in summer. It should be noted that this treatment will not injure sheep or any other animals in any way. One treatment with bluestone is not necessarily sufficient, as its efficiency is lost after about one week; therefore it is well to repeat the sprinklings from time to time.



Fig. 4.—Common Fresh Water Snails
(Natural size).

A. —Fluke Snails (*Limnea brazieri*). These may be distinguished by the fact that when placed face downwards on the palm of the hand with the point of the shell towards the observer the final coil of the shell curves to the right. Young fluke must undergo development within these snails, so that without them them fluke disease could not occur.

B. —Snails not known to be carriers of fluke. The final coil of the shell curves to the left.

The fluke snail has two egg hatchings annually, one in December and the other in July. The eggs are deposited in jelly-like masses about half an inch in length, each mass containing about 40 eggs. These egg masses are not affected by bluestone, consequently it is imperative that the snails should be destroyed before they lay their eggs, thus bluestone must be broadcast not later than November and June in each year.

Copper sulphate or bluestone costs about 6d. per lb., and as the treatment of affected pastures is simple, and so inexpensive in proportion to the enormous amount of good that will ensue, all sheep-owners are urged to adopt these measures, and carry them out conscientiously.

Sheep-owners should make themselves familiar with the appearance of the fluke snail, and then cause a careful search to be made for them in shallow water around the edges of swamps and in small pools. All should join in a united effort to destroy the

snails; by so doing hundreds of thousands of pounds will be saved annually by the sheep-owners of Australia.

Summary.

To summarize, it is well to draw particular attention to the following essential points:—

- (1) Fluke disease is caused by a leaf-like worm in the liver.
- (2) Fluke eggs cannot hatch in the absence of moisture.
- (3) The young fluke must have a particular snail available to carry on its existence.
- (4) Sheep affected with adult fluke can be freed of fluke disease by the use of carbon tetrachloride.
- (5) Fluke disease can be entirely removed from infested properties by draining all swampy areas, and by following this up with bluestone treatment of moist lands to destroy the snails.

Establishing Mixed Pastures

(Continued from page, 66.)

be a fine, firm seed bed free from weeds and weed seeds. The seed is then sown on the surface and subsequently covered by light harrowing or rolling, or both. The importance of surface sowing can be understood when it is realized that the food supply in the small seed has to suffice until the green shoots are through the ground and able to perform their function in the life of the plant. The finer grazing plants such as rye-grass will fail under any system other than shallow sowings, whereas the coarser grasses will tend to persist and obtain the upper hand.

At the time of sowing it is advisable to topdress the field with superphosphate at a rate shown to be the most economical in the particular district; but not less than 1 cwt. per acre. This topdressing will stimulate the plants in their early stages promoting a quicker and stronger growth which enables them to compete more successfully with the annual weeds.

With good seeds sown under good conditions it only remains for careful after management of the pasture to ensure a field of high carrying capacity and a stand-by in times of stress.

The seven principal points put forward relating to the autumn sowings of permanent pastures may be summarized as follows:—

1. Soil preparation—a fine, firm seed bed free from weeds and weed seeds is essential.
2. The pasture plants to be selected—the selection depending on—
 - (a) rainfall, its amount and seasonal distribution;
 - (b) soil type;
 - (c) the requirements of the farm.
3. Strain of the pasture species. For permanence it is essential to have long-lived strains of all species rather than annual or false perennial strains.
4. Time of sowing—after the first autumn rains and before the winter lowering of temperatures sets in.
5. Method of sowing—surface sowing with subsequent harrowing or rolling, or both.
6. Top-dressing at the rate of at least 1 cwt. of superphosphate per acre.
7. Careful management, particularly during the early stages of the pasture. This, however, is another subject which will be dealt with at some future time.

Crop and Fallow Competition

Results at Hopetoun

Report of the Judge, Mr. W. B. Miller, M.Agr.Sc., Inspector of Agriculture.



Wheat Variety Trials, Mallee Research Station, Walpeup.

DURING recent years seasonal conditions in the Western Mallee have been characterized by heavy autumn and winter rains, followed by somewhat dry springs. Efficient fallowing has been difficult because of the prolific growth of weeds and the irregular rainfall, but growers have been able to sow large areas of wheat either on fallowed or late cultivated land, and to establish the crops before the critical months of September and October. Very high average yields have been prevented by the comparative failure of the spring rainfall. Fortunately the deficiency this year has been offset to some extent by the cool weather and absence of scorching winds, thus enabling the crops to produce well-filled grain. The inspection of crops in the Hopetoun district showed no more than the usual amount of disease, such as take-all, to be present, and it was concluded that estimates of yields made early in November would be exceeded. The average yield of crops entered in the fallow and crop competition was estimated to be approximately $7\frac{1}{2}$ bags per acre.

Wheat Varieties.

One of the many objects of wheat crop competitions is to record the varieties grown

by competitors and to make public this information. Such men naturally grow what they consider to be the most prolific varieties for the conditions obtaining on their farms and, generally speaking, they are to the fore in adopting new varieties. Normally, the areas shown by competitors are those from which the highest yields are expected, and such areas are sown at the most opportune time. The varieties most prominent in crop competitions are generally well suited for the sowing of the main crop. It must be remembered, however, that the whole of the crop cannot be sown under ideal conditions, and some must necessarily be sown later than is desirable. The choice of the most suitable variety for this later sowing is of great importance and an early maturing type is required. The yield obtained from such a variety sown late may not be equal to that which would have been obtained from an earlier sowing, but as early sowing over the whole area is impossible the net result will be a greater average yield per acre. The results of trials at the Mallee Research Station, Walpeup, strongly support this principle.

The standard varieties now grown at Hopetoun are Free Gallipoli and Rancee. Sown early, Free Gallipoli may outyield Rancee,



A Crop of Ghurka at the Mallee Research Station, Walpeup.

but the latter, an earlier maturing variety, is to be preferred for later sowings. Nabawa, a variety which matures even more quickly, may be useful for the same reason, but in tests it has not yielded as heavily as Rancee. For sowing on land where previous experience has shown that flag smut may thin out the crop and reduce yields, Nabawa is useful, as it is almost immune to that disease. However, the sowing of large areas with this variety is not advocated owing to its weakness in the straw.

For sowing on reasonably clean fallow early in the season, Ghurka is recommended. It is a short-strawed, though late-maturing variety, and for several years has yielded consistently well in all trials in the Mallee.

Cultivation Methods.

It cannot be said that the crops shown in the competition were grown on land that had been over-cultivated from an economic point of view. In fact, some competitors were unable to cultivate their fallow in what may be regarded as a normal manner. Delayed sowing in 1931, the heavy growth of weeds, grasses, and self-sown crops, and the dry spring following all interfered with fallow preparation. It is significant that the heaviest crops were

grown on what were judged to be the better fallows. This does not always happen, for the natural fertility of the land, its cultivation after harvest, time of sowing, and other factors possibly are more important than the actual appearance of a fallow in November. Exceptional instances may occur, but experience of many seasons has shown that highest yields will seldom be obtained from fallow which is not in reasonably good order by the end of the spring. To obtain this result, it is necessary to break up the land by mid-July, to keep it free from excessive growth of weeds from then onwards, and to prepare a firm seed bed and loose mulch by cultivation. The control of grass and weed growth and soil preparation usually are simultaneous operations, and seldom is it necessary or advisable to cultivate Mallee soils unless weed growth is present.

The times for carrying out the various operations vary so much with the seasonal and individual farm conditions that no general recommendation is possible. Briefly, practical fallowing in an average season would comprise the original fallowing with the plough or some type of cultivator as early as possible, two strokes with a cultivator before harvest and one in the autumn before sowing with the combine. The harrows should be used sparingly

and sheep will assist greatly in the control of most weeds. The difficult economic situation cannot be overcome by the neglect of such proved cultivation practices.

Awards in the crop competitions are shown in the accompanying table:—

SECTION 1.—75 ACRES OF FALLOW, 1931, AND
CROP GROWN ON THAT FALLOW, 1932.

Open Class.

Competitor.	Crop Total, 1932.	Fallow Total, 1931.	Grand Total.
Maximum Points	100	100	200
J. E. Carra, No. 2 (Nabawa) ..	92	88	180
J. E. Huf (Ranee)	87	89	176
J. E. Carra, No. 1 (Nabawa) ..	82	93	175
Robt. Poulton (Gallipoli) ..	84	90	174
H. E. Poulton (Bena and Gallipoli)	83	86	169
J. J. Sheehy (Gallipoli) ..	76	91	167

SECTION 2.—50 ACRES OF FALLOW, 1931, AND
CROP ON SAID FALLOW, 1932.

Open to Returned Soldier Settlers only.

Competitor.	Crop Total, 1932.	Fallow Total, 1931.	Grand Total.
Maximum Points	100	100	200
G. Barnes (Ranee)	81	94	175
D. Creek (Gallipoli)	79	94	173
J. Sheehy (Gallipoli)	77	91	168
K. Dodgshun (Gallipoli) ..	75	87	162
E. Schoefield (Gallipoli and Ranee)	77	..	..

Comments on the Crops.

The winning and heaviest crop inspected was one of Nabawa grown by Mr. J. E. Carra on a medium red loam paddock. It was sown in mid-April with 60 lb. each of seed and manure per acre. The crop was tall and had developed a slight lean without going down. The heads were large and well filled, very little disease was present, and, but for a few wild oats, the crop was clean.

An early variety sown early, it was suited by the season. The paddock had been in constant cultivation for some years. In June, 1931, the stubble was burnt, and the fallow prepared with the sunder-cut working three

inches deep. The land was cultivated twice before harvest, harrowed after rain in February, rigid tyne cultivated at the end of March, and sown a fortnight later.

Second place in the open section was secured by Mr. J. E. Huf on lighter country. Ranee was the variety used, sown in the latter half of May at the rate of 66lb. of seed and 57 lb. of manure per acre. The fallow was treated similarly to that described above, but the sundercut was used to deal with paddy melons in February.

The remaining crops were not so thick or had been attacked by take-all in patches. Flag smut was responsible for thin crops in some instances. Ball smut was detected in one crop; this disease is still present in many Mallee crops, and careful pickling should be continued to eradicate it. The average quantity of seed sown per acre was 62 lb. and of superphosphate 70 lb. per acre.

The Fallows.

Many of the fallows submitted were good, but some showed signs of neglect early in the spring. When barley grass and weeds get away at that time, the quality of the fallow suffers. To control heavy weed growth in the spring is more important than the eradication of a few scattered thistles in the summer. Points were deducted where evidence of much recently killed weed growth was present.

Awards for the fallows are as follows:—

OPEN COMPETITION—BEST 75 ACRES OF
FALLOW.

Competitor.	Maximum points	..	..	100
Poulton, Robt., No. 2	..	..	..	94
Creek, D.	..	..	..	93
Poulton, Robt., No. 1	..	..	..	93
Marshman, G. C.	..	..	..	91
Hofmaier, H. E.	..	..	..	91
Carra, J. E.	..	..	..	90
Sheehy, J. J.	..	..	..	89
Huf, J. E.	..	..	..	86
Poulton, H.	..	..	..	85

SOLDIER SETTLERS' COMPETITION—BEST 50
ACRES OF FALLOW.

Competitor.	Maximum points	..	..	100
Creek, D.	..	..	..	94
Fraser, R. J.	..	..	..	93
Barnes, G.	..	..	..	93
Dodgshun, K.	..	..	..	90
Sheehy, J. J.	..	..	..	90
Schoefield, E.	..	..	..	90
Goudie, J.	..	..	..	87

From a practical point of view there was little to choose between the leading fallows. A good, even mulch, not too fine, had resulted from either two or three cultivations after the initial ploughing early in the winter. That shown by Mr. R. Poulton had been ploughed three inches deep in July, scarified in August, again crossways in September, and one portion again early in November. The ridges left by the cultivator working north and south had arrested some of the drift at that stage. The cultivation had been thorough and the depth of mulch, about $2\frac{1}{2}$ inches, was very even.

Mr. Creek, who leads in the section reserved for soldier settlers, showed a fine fallow also. Mr. K. Dodgshun had obtained better results than might have been expected for a fallow ploughed in August, harrowed in September, and cultivated in October. Points are awarded only on the appearance of a fallow, but conserved fertility due to early fallowing will make itself felt in the crop.

The number of competitors, 13, was not as great as in some competitions of the past. More entries would increase considerably the value of the competition to the district.



A Crop of Rajah at the Mallee Research Station, Walpeup.



Mallee Wheat Tests

Swan Hill Results, 1932

THE results of the wheat experiments conducted by the Department of Agriculture at Swan Hill showed that the very satisfactory average yield of 33 bushels per acre had been obtained from the plots. The tests, which comprise variety and manurial trials, are carried out on the farm of Mr. G. D. Brydon, on red sandy loam typical of the district soils.

In the variety trials, eleven wheats were tested under the replicated system, the plot of each variety being repeated five times. The plots were sown on fallow in the last week of April, with 65 lb. of seed and 76 lb. of superphosphate per acre. The yields were:—Ghurka, 42 bush. per acre; Sepoy, 39.3; Free Gallipoli, 38.2; Federation, 36.9; Ranee 4H, 33.7; Currawa, 32.6; Omrah, 31.1; Penny, 29.4; Nabawa, 27.2; Rajah, 26.6; and Early Gluyas, 21.2 bush.

The season at Swan Hill commenced well, excellent rains totalling seven inches being received from January to April. Over the next five months ending September, a further eight inches was recorded. During October and November, however, the rainfall was comparatively light, but the cool weather conditions experienced over that period enabled the heads to fill exceptionally well, and heavy yields were obtained.

In the case of several of the early maturing varieties, including Early Gluyas, Nabawa, Rajah, and Omrah, the yields were reduced through lodging, while with the variety Penny the return was lowered by shedding.

Ghurka, which has been included in the Swan Hill plots for the past two seasons, has given the highest yield in both years. During the last five or six years, this variety has given very satisfactory returns in many experimental plots in the Mallee and other parts of the wheat belt, and probably would prove very suitable for Swan Hill. It is a short strawed, mid-season to late wheat suitable for early sowing, and excellent to handle at harvest.

Over the four years in which the tests have been conducted at Swan Hill, Sepoy, Free Gallipoli, and Ranee have given the best yields, and can be safely recommended for general use in the district. Rajah also has yielded well, but, because of its tendency to shed its grain, farmers are advised to restrict their sowings of this variety to a small area. Rajah is an early maturing wheat suitable for late sowing. The average yields over the past two years, during which the plots have been sown in randomized blocks, are as follow:—

AVERAGE YIELD—TWO YEARS.

	Bushels per acre.
Ghurka	35.0
Sepoy	33.3
Free Gallipoli	32.1
Ranee 4H	28.9
Currawa	28.8
Federation	28.8
Omrah	27.2
Rajah	27.1
Penny	27.1
Nabawa	25.3

The manurial plots were sown on April 28th with Free Gallipoli wheat at the rate of 65 lb. per acre, and the yields were as follow:—No manure, 35.3 bush.; super., 60 lb., 36.9 bush.; super., 90 lb., 37.7 bush.; super., 120 lb., 37.5 bush.; and super., 150 lb., 38.0 bush. per acre.

The average results from these tests over the last four years show the following increased yields from varying dressings of superphosphate, compared with the return from the no-manure plots:—1.5 bush. per acre from super. 60 lb.; 1.9 from 90 lb.; 2.5 from 120 lb.; and 3.0 from 150 lb. Valuing this extra wheat at 2s. 6d. per bushel and deducting the cost of the super., the extra monetary return per acre so obtained is as follows:—from super. 60 lb. per acre, 1s. 1d.; super. 90 lb., 9d.; super. 120 lb., 11d.; and super. 150 lb., 10d.

Beulah Crops and Fallows

Competition Results

Report of the Judge—W. B. Miller, M.Ag.Sc., Inspector of Agriculture.

WHEAT crops inspected in the Beulah district competition were estimated to return an average yield of eight bags of good quality grain per acre, and were of a standard at least equal to the average of recent years. When it is remembered that, by the end of 1931, farmers had been unable to prepare the usual area of good fallow, the result, from a yield point of view, must be regarded as satisfactory. So unusual was the fallowing season of 1931 that the fallow competition for that year was abandoned. Heavy winter rains, the rapid growth of grass and weeds, and the dry spring combined to make fallow preparation difficult. Fortunately, the propitious rains early in 1932 provided the much-needed opportunities to put the fallows in order, and also to prepare stubble ground where the fallowed area was limited. The rain received during the growing period was sufficient to carry the crops on, and only the dry period in September prevented the realization of high yields. Some stubble sown crops returned good yields, but those grown on reasonably good fallow were, on the average, much heavier.

All the competition crops were grown on fallow and competitors were unanimous in stating that the best crops were to be found on the best worked land. Serious attacks of takeall were not noticed except in crops grown on stubble land or on badly neglected fallow.

Cost of Cultivation.

In times of adversity such as the present, it is natural and desirable to investigate all possible means of reducing the cost of cultivation. Some of the practices which have to be considered in growing each individual crop can not be modified to any great extent without consequent losses. For example, adequate seeding and manuring are essential, and the choice of suitable varieties involves little expense. The custom of growing the major portion of the crop on fallowed land wherever possible has been proved a sound practice for such a long period that few growers contem-

plate any reduction in the proportion of their crop to be sown on fallow. On the other hand, growers may consider that the cost of cultivation will be reduced if the fallow is not given the attention which has been regarded as profitable when wheat prices were higher than at present. The difficulties experienced in maintaining tractive power either by horses, which are now difficult to obtain, or by tractors, have encouraged this tendency. Sufficient team strength is one of the most important factors in wheat farming, and without it a grower is hopelessly handicapped. Particularly is this the case at sowing time, when "time is the essence of the contract." Given the strength required to cultivate and sow in the autumn, then the strength to prepare and cultivate the fallow well but economically is automatically available.

There is little to be saved in cash outlay, but in all probability much to be lost in yield per acre by any drastic curtailment in the proved practices of fallow cultivation.

A review of the methods adopted by exhibitors in the various competitions illustrates the important fact that what may be the correct procedure and management for one grower may be quite wrong for his neighbour. The ideal probably will be the same in both instances, but the circumstances, financial position, area of land available, possession of teams and implements, and the availability of family labour may dictate different methods.

The principal object of crop competitions is to discover and make known the methods by which the best crops are grown. The extent to which these methods should be varied for special circumstances is a matter for serious consideration by each individual grower.

Competition Crops.

The crops shown this season were truly show exhibits, as they were chosen shortly before judging took place, and were not grown on land nominated in the previous year as is the usual practice in fallow and crop competitions. Nevertheless, some competitors who had little

chance of winning entered their crops, and by so doing showed their appreciation of the real objects of the competition, which are educational rather than competitive. It is hoped that more growers will enter in this spirit in years to come.

The competition was for the best 100 acres of crop grown on any class of land, light or heavy. Some difficulty was experienced in choosing between the leading crops, as, on the whole, they were heavy and well headed. On the heavy red ground and on "snuffy" or limey patches, the crops were lighter than on the good red loam or on the black ground. Wild oats and mustard were present in most crops, but had not seriously reduced yields. Losses due to disease were small, though take-all was present and flag smut had thinned out the wheat in some instances.

The varieties exhibited were Free Gallipoli, Rancee, Ghurka, and Nabawa. Federation and Penny, which have lost popular favour, were conspicuous by their absence, having been proved inferior to the standard wheats, Gallipoli and Rancee, for general use. The consistent adoption of varieties by growers after they have been tried out for five and six years in reliable experimental plots is sufficient evidence of their worth.

Ghurka, which during the past four years has given the highest yield in the plots conducted by the Department of Agriculture, deserves more attention by district farmers. It is short strawed and, therefore, it may be unwise to sow it on weed-infested land. Both Ghurka and Gallipoli should be sown before the earlier maturing varieties, Rancee and Nabawa.

The rate of seeding used by competitors varied from 65 to 75 lb. per acre. For early sowing one bushel of average size seed per acre should be sufficient, but when sowing in June, or when the grain is larger than usual, the weight sown per acre may be increased considerably. The average application of manure used was 68 lb. per acre, any increases on which could not be expected to materially increase the returns. The majority of the crops were sown by the end of May, and in nearly all seasons sowing after this time in the Mallee will result in lower yields.

The winning crop of Free Gallipoli, grown by Mr. L. E. Brennan on good loamy country, was part of a large paddock sown with that variety, which now comprises all his crop. It was not perfect, inasmuch as some diseases and weeds were present, but was regarded as the best ex-

hibit. On lime and blown patches of ground the crop was thinner than on the red loam. The land had been under cultivation for many years. The methods of cultivation used were well suited to the season. The paddock was plowed with the mouldboard in July to a depth of 3 inches, skim plowed in September as soon as the soil had dried out sufficiently, and then combined in October. In April, weeds were killed with the combine, and the crop was sown at the end of May, using 70 lb. each of seed and manure per acre.

Mr. W. G. Chivell's crop of Rancee included the heaviest portion of crop inspected, this being on black ground, a box flat. On the lighter ground the crop was not so heavy. The heads were not particularly large, but the crop was very thick. The heavy land was particularly difficult to deal with when fallowing, and intense cultivation was required to put it in order. After fallowing with the sundercut in July, the land was harrowed once and combined twice in the spring and was later combined in February, harrowed in April, combined again in May, and sown early in June, using 70 lb. of seed and 62 lb. of super per acre. Rancee is a very suitable variety for sowing in June.

Mr. W. A. Riseborough's crop of Gallipoli and Nabawa was also a fine one, grown on average buloke and pine country. The Nabawa showed a weakness in the straw, for which a point was deducted on the score of evenness. The fallow had been thoroughly cultivated as the season permitted, and the crop was sown at the end of May and early in June with 60 lb. of seed and 70 lb. of manure per acre.

Messrs. Bodey Bros., on pine and mallee country, included a considerable area of Ghurka variety, which promised well. Unfortunately, this seed was far from pure. The awards are shown in the accompanying table.

BEST 100 ACRES OF WHEAT CROP, 1932.

Competitor.	Variety.	Total Points.
L. E. Brennan ..	Free Gallipoli ..	87
W. G. Chivell ..	Rancee ..	86
W. A. Riseborough ..	Gallipoli and Nabawa ..	86
Bodey Bros. ..	Ghurka and Gallipoli ..	83
L. E. Gniel ..	Free Gallipoli ..	83
— Murray ..	Rancee ..	81
L. W. Thompson ..	Rancee ..	81

The Fallow Competition.

Nine entries were received in the fallow competition. Here again more entries would have increased considerably the value of the contest. Most of the fallows shown were of quite a high standard. Those farmers who had only small areas to work were able to have their fallow in almost ideal condition. Others with larger areas had succeeded in maintaining good practical fallows, plowed early and kept reasonably free from weed growth. Some fallows noticed in the district showed signs of neglect, said to be due to many causes. It is a pity to see good land in such condition.

Mr. L. E. Gniel showed a paddock of fallow which could hardly be faulted. The land is rather heavy red and grey loam, and is not so light to work as the pine country. The moisture content was good for heavy land, the mulch in a nice crumbly condition, and left in ridges, and there were few signs of weed growth having been excessive in the winter or spring. In the previous year, oats were cut, and then the stubble was sundereut in March after rain. In June the sundereut was used again, the scarifier in July, and the spring tooth in August, September, and October.

Mr. McLean's fallow showed a higher moisture content than the heavier ground of the winner, but, though well cultivated, was not so perfect. The stubble of a self sown crop

had been burnt, and plowing took place in July. Afterwards the harrows were used, followed by the spring tooth cultivator in September, and again in October.

Mr. Sandford had prepared his fallow without the help of sheep to any extent. It was presented in very good order, but showed signs of weeds in places. Plowing took place in July, followed by the harrows. The scarifier was used in August, and the combine in September. The last working given with the harrows in November was hardly necessary.

With one exception, all the fallows shown were commenced before the end of July. An early commencement is the foundation of good fallowing, and time lost in June and July is difficult to make up. The closeness of the points awarded in the table shown below indicates the uniformly high standard of the fallows:—

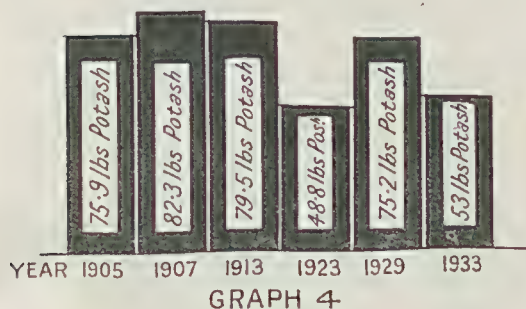
FALLOW AWARDS.

(Best 100 acres of Fallow.)

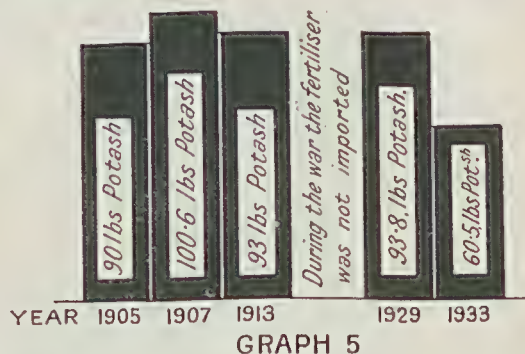
Competitor.	Total Points
L. E. Gniel ...	96
J. A. McLean ...	95
P. W. Sandford ...	95
L. R. Shannon, No. 1 ...	94
L. R. Shannon, No. 2 ...	94
Murray ...	93
Bodey Bros. ...	92
W. G. Chivell ...	91
L. W. Thompson ...	90

Artificial Fertilizers

The two graphs hereunder are to be substituted for graphs 4 and 5 printed in this *Journal* for January, 1933, page 30.



Showing number of pounds of potash received for every 20s. expended on sulphate of potash during the period 1905-1933.



Showing the number of pounds of potash received for every 20s. expended on chloride of potash during the period 1905-1933.

Northern Mallee Wheat Trials

Results at Werrimull, 1932

INTERESTING results have been obtained from the wheat variety trials which were initiated last year at Werrimull, in the Millewa, in accordance with the Departmental policy of an extension of research in the Mallee. The experimental field is located on the farm of Mr. H. H. Scott, the soil being representative of a large proportion of typical Mallee country.

The incidence of the rainfall during the season was particularly favorable to early-sown wheat. The total rainfall of 1,226 points included good falls from February to August. Cool weather and moderate rains during the later months enabled the crops to finish with excellent yields.

The variety trials were designed to test fifteen varieties, including three promising new crossbreds, and were sown early in May, using 50 lb. of seed and 75 lb. of super. per acre. To ensure accuracy, five plots of each variety were sown on the replicated system. The following were the average yields obtained this season:—Ghurka, 35.6 bushels per acre; Major x Rancee, 31.6; Sepoy, 31.1; Rancee 4H, 31.0; Early Gluyas, 30.8; Free Gallipoli, 30.0; Currawa, 30.0; Rancee x Gallipoli, 30.0; Mac's White, 29.9; Nabawa, 29.6; Currawa Ind E x Telfords, 29.3; Yandilla King, 29.1; Rajah, 29.0; Waratah, 28.5; and Omrah, 28.0. Several of these varieties have been tested over many years on the Carwarp property of the late Mr. P. G. Stewart, M.H.R. The average yields for both sets of plots for the past nine years are shown in the accompanying table:—

Variety	Average 9 years. Bushels per acre.
Ghurka	17.2
Sepoy	16.9
Rancee 4H	16.1
Mac's White	16.0
Rajah	15.8
Free Gallipoli	15.6
Currawa	15.4
Yandilla King	15.4

It will be noted that Ghurka, which is the leading variety at Werrimull this year, also has the highest average yield over the nine years' period. It is a short-strawed wheat, maturing mid-season to late, and when sown early has given the highest yields in many trials. On account of its short straw it is best suited to well-cleared country, and should be sown before such early maturing varieties as Rancee or Rajah. Sepoy, also a late maturing wheat, has yielded consistently well at Carwarp.

Of the early maturing varieties, Rancee 4H, an improved selection of Rancee, appears to be the most suitable for general sowing, though Rajah, which has proved most suitable for late sowing, can be depended upon to give fair yields, even in dry years. Of the new crossbreds, Major x Rancee appears to be the most promising, but the results from future trials will be needed to verify this.

Time of Sowing.

One of the outstanding results from this year's plots was obtained from the Time of Seeding trials. Plots were sown at three periods:—(a) early in May; (b) mid-season, at the end of May; and (c) late season, at mid-June. The variety used was Rancee, and the plots were sown in the usual manner. The average results shown in the accompanying table demonstrate the importance of early seeding for the Mallee.

Time of Seeding.	Yield. Bushels per acre.
Sown early	33.2
Sown mid-season	27.0
Sown late	18.8

The fact that the results from the Carwarp plots also definitely favoured early seeding indicates that this practice is of the utmost importance to the farmers of the north-west. The Department strongly advises that cultural operations should be commenced sufficiently early to allow seeding to be commenced in April and finished before the middle of May.

Pseudo Poultry Plague

The Second Outbreak

By R. N. Johnstone, B.V.Sc., Senior Veterinary Officer.

IN this article it is proposed to discuss pseudo-poultry plague or Newcastle disease of poultry, which has again made its appearance in Victoria. The first cases of this disease in Victoria were discovered in December, 1930. Consequent upon that discovery, quarantine restrictions in respect of poultry were imposed on the whole State, while a survey was carried out in order to ascertain the spread. Fortunately, this survey disclosed that the disease had not invaded the country districts to any great extent, although one outbreak had occurred at Dalyston and one at Kyneton, and, therefore, it was found possible to remove the restrictions from all country districts, and to confine our attentions to the suburban and outer-suburban districts. In all, 72 farms became infected, involving 22,284 head of poultry. On that occasion, the last outbreak occurred on 6th March, 1931; and on 4th June, 1931, quarantine restrictions were removed, and the whole State was then considered to be free from the disease. Every endeavour was made to trace the source of that outbreak in order that measures might be adopted to prevent further incursions, but the means of entry could not be definitely determined.

The disease previously had made its appearance in several countries. In 1926, it appeared in Java and spread with such rapidity that during 1926 and 1927, about five million head of poultry died of the disease in that island; practically speaking, it exterminated all the poultry. The disease was investigated and described by a veterinarian, Picard, who found that pigeons, crows, fowls, ducks, swans, geese, turkeys, parrots, and live wild fowl, were susceptible to and capable of spreading the disease.

In 1927 and 1928, an outbreak of disease amongst poultry was investigated and described at Ranikhet, a Himalayan province in India. A large number of flocks were affected in widely separated localities; 85 per cent. of the birds in affected flocks died, and

crows were found to be susceptible. In the spring of 1926, a disease appeared on a poultry farm near Newcastle-on-Tyne, England, and was investigated by T. M. Doyle, F.R.C.V.S., of the Veterinary Laboratory of the Ministry of Agriculture, England. It is interesting to note that birds on this farm were fed on offal collected from Newcastle. Subsequently, two further outbreaks occurred in England—one in Somerset, where 100 per cent. of the birds on affected farms died, and another in Staffordshire. This latter outbreak was very extensive and involved many farms. There was ample evidence in this instance that its wide distribution was due to the sale of affected birds in a local market.

All these outbreaks had been investigated and reported independently, and it was not



Characteristic appearance of a bird during the early stage of the disease.



Typical Respiratory Symptoms.

until the International Poultry Congress was held that it was realized that the Newcastle disease, the Ranikhet disease, and the outbreaks in Java were identical.

In every country in which outbreaks of this disease have occurred, a second outbreak has made its appearance during the following year, and we have proved no exception to the rule. On October 6th last, several fowls were brought to Dr. Albiston at the Veterinary Research Institute by an owner for diagnosis and treatment. On examination of these birds Dr. Albiston discovered symptoms of Newcastle disease, but in order to be definitely certain that that disease was present, healthy fowls were injected with material taken from the sick birds, and four days later the experimental birds showed definite evidence of the disease.

It then became necessary to again impose quarantine restrictions on the suburban and outer-suburban areas, and to institute definite measures of control. These measures cause a considerable amount of disorganization in the egg and poultry trade, and some degree of consternation amongst keepers of poultry in this State. That such measures are necessary and that they are in the interests of the industry must be apparent to those familiar with the disease and the means by which it is spread.

The organism which causes the disease is so minute that it cannot be seen under the highest power of the microscope. It will pass through the finest filter, and birds have been infected

by Dr. Albiston by the injection of material which has passed through such a filter.

The incubation period—that is, the period which elapses between actual infection and the development of symptoms—is from three to nine days. The symptoms shown by affected birds in the present outbreak vary in some details from those shown in the last outbreak. In that outbreak, affected birds almost invariably showed a thick mucus discharge from the nostrils and in the mouth a varying amount of frothy exudate, which hung in threads from the end of the beak. Curiously enough, in the present outbreak very few birds develop this symptom, but by a cross immunity test, Dr. Albiston has proved definitely that it is a recurrence of the same disease. The first symptom noticed is that the bird becomes sleepy and will stand by itself, the tail droops, and every now and again the bird will shiver or make a convulsive movement. The respirations are increased; there is a watery, yellowish-white, foul-smelling diarrhoea. As a rule the crop is distended with a sour-smelling greyish-brown fluid.

In cases which occur on the farm, the comb and wattles become dark in colour. The most characteristic symptom noticed is in connection with the breathing: there is a long gasping inhalation through a half-opened beak. This is frequently accompanied by a convulsive twitching of the neck. In an infected flock one or more birds invariably will be discovered with this symptom. Occasional birds may die without showing any symptoms. Death usually occurs between the first and sixth days after symptoms develop, but a few may live much longer and some may even recover. These birds, however, become partially paralysed as the disease progresses, and those which continue to live remain paralysed in one or more legs, or have their necks distorted, and are quite useless for practical purposes.

As with most diseases of this nature, the post-mortem lesions are not constant. As a rule, however, the skin and muscles will be found to be slightly darker than normal. In the fat around the gizzard, a number of dark red blotches or spots, due to haemorrhage, may be noticed. The small bowel immediately behind the gizzard shows haemorrhagic blotches. The lining of the sac immediately in front of the gizzard—the proventriculus—is found to be haemorrhagic. The sac around the heart sometimes has an excess of fluid. The contents of the bowels are frequently grey in colour, and liquid.

The droppings, the discharge from the mouth and nose, the blood, and every portion of the body of the bird are infectious; and therefore the disease may be spread by feeding birds on hotel offal which may contain uncooked portions of affected birds or bread scraps, leaves or peelings of vegetables which have been soiled by the hands of persons who have stuffed and trussed birds for cooking, or shells of eggs which have been soiled on an infected farm. It may also be spread by fowls which come in contact with infected birds in markets, or which are placed in crates or coops which have been occupied by infected birds or soiled by their droppings. It may also be carried from one pen to another or from one farm to another by persons whose boots have become soiled with the droppings of infected birds, or by birds such as sparrows, starlings, doves or pigeons, which have visited an infected pen for food and have subsequently visited a clean farm for the same purpose.

Because of the danger of the spread of the disease, it has been found necessary to prevent the unauthorized movement of poultry and to impose restrictions on the sale by auction of poultry. Certain auction rooms in the metropolitan area were set aside for the sale of poultry from outside the quarantine district. Owners who desire to sell poultry at these rooms must apply to the Chief Veterinary Officer for permission to introduce these birds to the auction room chosen, and must complete a declaration form or furnish a statement that the birds have been in their possession for 28 days, and that no disease has appeared on their farm. A written permit is then issued, and this must accompany the birds from the farm to their destination. Poultry forwarded on a declaration may be used for re-stocking purposes; those on a statement are for slaughter only.

In order to facilitate the sale of surplus poultry from healthy farms which are within the quarantine district, certain auction rooms which have provided facilities for the slaughter and dressing of poultry, are allowed to be used for the purpose of sale by auction of these birds. Owners must forward a declaration of health in respect of all poultry on their farm, on receipt of which a written permit covering the movement from the farm to the auction room is issued. This permit must accompany the birds to the room, and all poultry entering the room is slaughtered and dressed in the space provided for that purpose. No birds are allowed to leave these auction rooms alive.



Showing Respiratory Symptom and Paralysis of the Leg.

Forms of declaration or statement forms for movement of birds may be secured from the Chief Veterinary Officer on application.

Several premises in the city and suburbs have been approved as slaughter places for poultry, and poulterers or other persons may take poultry bought at clean auction rooms or privately there on permit for slaughter under supervision. All poultry slaughtered at these approved places is fire-branded with a brand in the form of a crown within a circle. This brand may be regarded as a guarantee that the bird at the time of slaughter was free from disease. All carts, vehicles and crates used for conveyance of poultry to auction rooms or slaughter places are thoroughly disinfected before leaving the premises.

No restrictions are placed on the sale within Victoria of eggs from clean farms. Infected farms will be strictly quarantined, removal of birds except for immediate slaughter prevented, and eggs suitably disinfected before removal.

All Australian States have totally prohibited the introduction of poultry from Victoria. New South Wales has also prohibited the introduction of poultry crates. Eggs may be forwarded to that State on a declaration, on a form provided for the purpose, that they have been produced on a farm which is more than 15 miles from any outbreak of the disease, and that the box in which they are conveyed is new or has been disinfected in accordance with the procedure laid down. Egg declaration forms may be procured from the Chief Veterinary Inspector or the Chief Poultry Expert, and must be certified by an Inspector of Stock.

During his investigations, Dr. Albiston has tested the effect of a number of disinfectants

on the virus of this disease. Hypochlorite of soda at the strength of one ounce to four gallons has proved effective, and has been adopted for the purpose of disinfection in the present outbreak.

Owners of poultry should take the following precautions:—

1. If any birds on the farm show symptoms resembling those mentioned, notify the Chief Veterinary Inspector immediately.

2. Do not visit infected farms out of curiosity. If such a visit is unavoidable, clean and disinfect your boots and any portion of your clothing which may have become soiled, by washing with a solution of sodium hypochlorite before entering your own or another poultry farm.

3. Do not feed raw refuse from shops, hotels or restaurants to birds. Always cook the material before feeding.

4. Do not feed egg shells from any source to your poultry.

5. Arrange your poultry pens in such a manner that it is not necessary to enter the pens for the collection of eggs or the supply of food.

6. Add permanganate of potash to the drinking water at the rate of one ounce to 6½ gallons. Make separate drinking utensils for each pen. Avoid a continuous trough which will carry the disease from pen to pen.

7. An impervious partition about 2 or 3 feet high between pens will check the spread of the disease from pen to pen.



Failure to Report Outbreak

£5 Fine Imposed.

ONE of the first prosecutions under the Stock Diseases Act since the recent outbreak among poultry was dealt with at Oakleigh Court recently. Mrs. A. A. Yardley, of Centre-road, Oakleigh, was charged with having failed, between 1st October and 28th November, to notify the Department of Agriculture that pseudo poultry disease existed in her poultry.

J. Courtney, stock inspector, attached to the Department of Agriculture, said on 24th November he visited Mrs. Yardley's premises and examined a number of fowls. In one pen he found two dead fowls, and in another four or five birds were affected by pseudo poultry disease. A number of birds affected were

taken to the Veterinary Research Institute. The post-mortem examination which followed confirmed his (witness's) diagnosis. Mrs. Yardley had not notified the Department of the presence of the disease in her poultry.

Counsel for the defendant stated that the birds had been purchased in good faith by his client at a market. It was not until after the birds had been delivered that it was found they were affected by disease.

Mr. Wade, P.M., said the maximum penalty for the offence was £100. The Bench, however, thought a fine of £5, with £5 5s. costs, would meet the case. Apparently Mrs. Yardley had been deceived when she purchased the birds.

Wheat Growers Relief

Application Forms Available

Supplies of the special claim form which must be filled in by wheat-growers who desire to participate in the distribution of the £442,421, made available by the Commonwealth Government for the relief of Victorian wheat-growers, have been forwarded to the Post Offices at all rail towns in the wheat-growing districts and are now available to wheat-growers.

Under the *Wheat Growers Relief (Commonwealth Payment) Act 1932*, the money is to be distributed among farmers who sowed wheat in 1932 in the ratio which the area sown by the individual growers bears to the total area sown to wheat in Victoria in 1932. No payment will be made in respect of wheat crops cut for hay or self-sown wheat crops.

To participate in payments under the Act wheat-growers must comply with the following conditions:—

1. Supply all information required on the claim form.

2. Have their signature witnessed by one of the following persons:—Justice of the Peace, Commissioner for Declarations, Bank Manager, Stationmaster, Postmaster, Police Constable or Officer of Police, Land Officer, Inspector of Land Settlement, Town Clerk, Shire Secretary, Solicitor, Barrister at Law, Headmaster of a School, or Minister of Religion.

3. Must forward the completed claim form to the Inspector of Land Settlement for the district before 1st March, 1933.

4. Where an area of wheat has been sown under a share-farming agreement the payment in respect of that area will be apportioned between the parties to the share-farming agreement in proportion to their interests under the agreement. Each party to the share-farming agreement must submit an individual claim to cover that portion of the area on which he is entitled to payment. For example, if 300 acres of wheat have been sown and harvested for grain under an agreement which provides that A is to receive two-thirds and B one-third of the proceeds of the crop, then A must forward

a claim to cover the 200 acres on which he is entitled to payment and B a claim in respect of his 100 acres.

5. Payments will be made on wheat sown in Victoria only, therefore those Victorian wheat-growers who have sown wheat crops in either New South Wales or South Australia will not be entitled to receive any payment on such crops.

Three Departments—Lands, Treasury, and Agriculture—are co-operating in the administration of the Act which has been entrusted to a committee consisting of Messrs. P. Ryan, Inspector of Agriculture, who is Chairman and Executive Officer, E. P. Cameron, Chief Inspector of Land Settlement, J. Whitlock, Treasury Department, and J. A. Day, Department of Agriculture. The Committee will have the assistance of the Inspectors of Land Settlement, who will verify the claim forms submitted by wheat-growers in their district. The Closer Settlement Board has also made available the services of its supervisors to investigate claims. These officers will be authorized to require claimants to produce for inspection such documents, books, &c., relating to wheat as are considered necessary to verify any claim submitted.

A penalty of £100 or imprisonment for not more than 12 months or both is provided for supplying false or misleading information.

Any further information required may be obtained on application to the Chairman of the Wheat Growers Relief Committee, Department of Agriculture, from whom claim forms may also be obtained, but wheat-growers are asked wherever possible to obtain their forms from their local post offices.

The Committee administering the Act appeals to all wheat-growers to strictly observe the above conditions. By doing so they will help to reduce the cost of administration which is a charge against the Fund, and will facilitate payments being made as soon as possible after the last day for the receiving of applications.

Orchard and Garden Notes

By Edward E. Pescott, F.L.S.

The Flower Garden.

FOR the next six or eight weeks, the Gladiolus flowers will be in evidence in the garden. The treatment of the plant after flowering is important. Although the flower has gone, the new corm underground has not fully developed; to ensure that it will, the plant should be lightly watered at regular intervals, until the leaves begin to turn brown at the tips. As soon as this commences, the plant may be lifted. Lifting should be done carefully, so as to preserve all the small cormlets that have been formed. The plant should be air-dried—not sun-dried—for a few days; then the foliage may be cut off, the corms cleaned, and stored away in bags or boxes. The corms should be dry when stored, and in order to keep away mealy bug and aphids, they should be well dusted with lime.

Rose bushes should be cleaned out in order to prepare for autumn blooming. This work should not be in the nature of a winter pruning; cutting should be very light, and only the old flower heads and thin weak unproductive shoots cut away. The bushes should then be given a good manuring and watering. The best manure is stable manure, which should be applied as a mulch to a depth of six inches; failing that, a few ounces of blood manure should be worked and watered into the soil.

The Vegetable Garden.

Seeds of all root crops, and of the cabbage family, should now be sown. Those of cabbage, cauliflower, kohlrabi, and Brussel's sprouts, should be sown in a seed bed, having, as a

medium, a poor sandy soil. This encourages a stocky growth, and the seedlings do not become drawn and leggy. The plants may be manured after they are established in the beds.

Seeds of carrot, parsnip, turnip, and lettuce, should be sown in open beds consisting of a very well worked and loamy soil. The seed should not be sown deeply. After sowing, either in the rows or in the seed bed, scatter all over the sown area some well broken leaves from the leaf mould heap, to give coolness and shelter to the seed.

When the seedlings in the rows have grown to three or four leaf size, thin out to leave room for full development of the remaining plants.



The Orchard.

The orchardist who grows deciduous fruit will be busy with harvesting early fruits. Time should be taken to gather and destroy all rejected codling-affected fruits; in no circumstances should they be left about the orchard or sheds, as the grubs when disturbed quickly leave the fruits and look for a hiding place.

Citrus growers should now be dealing with the red scale pest which causes serious trouble to both fruit and trees. The young scale are on the move now, and either spraying or fumigation must be done by the end of February. White oil is the recognized medium for spraying, and two sprayings must be given. If the trees are fumigated, only one fumigation is necessary. Fumigation is by far the most effective method of dealing with scale.



Professional Papers

[This section is devoted to professional papers and articles of a scientific character.]

Irrigated Pastures

Results of Manurial Trials

By L. C. Birtels, B.Agr.Sc., E. T. Beruldsen, B.Sc. (Agric.), and A. Morgan, B.Agr.Sc.

WHEN mixed pastures have been successfully established under irrigation, their character and productivity are governed by grazing methods, manurial treatment, and watering systems. All of these phases of pasture management are under investigation at Werribee, and it is the aim to simplify the elucidation of the principles underlying these factors by examining each separately as a prelude to complex experimentation.

The problem of the rate and frequency of watering most suitable for the production of herbage has been investigated, and the results published in this Journal (April, 1932). It has been shown that the botanical composition of an irrigated pasture may be profoundly influenced by varying the watering treatment, and that the alterations in "personnel" are reflected in the total yield of herbage and the distribution of production over the year. The conclusion arrived at, after an analysis of yields, botanical composition, and chemical composition, was that "frequent waterings of moderate rate" was the best practice where dressings of 2 cwt. of superphosphate per acre per annum were given.

The question arises: "Can the above manurial practice be improved, increasing the productivity of the pasture and thus increasing the efficiency of the irrigation water supplied to it?" To obtain information on this point, a series of manurial tests was carried out concurrently with the watering tests, the site being a 2½-acre field adjacent to the latter.

History of the Field.

The plots were laid down in September, 1925—the grass and clover seed mixture (see this Journal, April, 1932) was drilled with the different fertilizers, and the manurial treatment has been repeated each autumn. When first sown the plots extended across a 10-chain



The Manurial Plots.

paddock; later, a dividing fence was erected, the design being to graze one section and to reserve the other for hay during spring, following which it was to be grazed regularly. The spring of 1925 was dry and unfavorable to the young pasture, but even in this early stage the plots receiving superphosphate appeared to advantage. In the succeeding seasons the two sections—north-west and south-west—began to assume different characters; the north-west section cut for hay became open and tufty, the south-west section grazed exclusively developed a dense even sward of grasses and clovers. It was intended to obtain the hay weights as an indication of the effects of different manures on production, but, because of the differences induced in the botanical composition of the herbage, yield of meadow hay is not a satisfactory measure of the productivity of grassland which is depastured; again, the yield at any one period cannot be taken as an indication of the yield over a year. This was illustrated by the fact that there was an obvious response to autumn dressings of nitrogenous manures, but this was not shown in the hay-weights. The carrying capacity of the two sections and the yields of hay recorded are given in Table 1.

The yields of hay obtained from the north-west section of the tests in 1927 and 1928 (a fine meadow developed in 1926, but a gale disturbed the hay-cocks and they could not be weighed) shew that the comparative yields from the plots give only slight indications of the value of phosphatic manuring so well brought out by a succession of close mowings. A better comparison of the two systems of recording results may be made by examining the

TABLE I.—SHOWING YIELDS OF GRASS HAY FROM THE VARIOUS PLOTS, PASTURE MANURIAL TESTS, FIELD 2 S.W.

(A.) N.W. Section, Seasons 1927-28 and 1928-29.

(B.) S.W. Section, Season 1931-32.

Also Data in Regard to Sheep-grazing.

Plot. (Rate of Manuring per acre.)	Yield of Grass Hay.		
	(A.)		(B.)
	1927-28 (Cut 22.11.27).	1928-29 (Cut 6.11.28).	Dry Matter 1931-32 (Cut 26.11.31).
No manure	338.5	220.0	271.6
Super., 1 cwt.	340.6	303.6	344.5
Super., 2 cwt.	360.7	333.6	382.6
Super., 3 cwt.	382.6	332.8	395.2
Super., 4 cwt.	395.9	348.5	410.5
No manure	358.1	309.4	334.1
Easic slag, 2 cwt. ..	354.0	385.0	456.0
Rock phosphate, 2 cwt.	323.8	325.1	423.6
Nitrate soda, 1 cwt. ..	313.9	353.6	417.9
Amm. sulph., 1 cwt. ..	296.7	339.2	447.5
Super., 2 cwt. + Nitrate soda, 1 cwt.	318.7	404.5	568.1
Super., 2 cwt. + Amm. sulph., 1 cwt.	320.6	402.6	518.0
No manure	292.6	376.3	410.3
Pot. sulph., 1 cwt.	296.9	367.1	424.7
Super., 2 cwt. + Pot. sulph., 1 cwt.	326.5	435.0	526.1
Super., 2 cwt. + Pot. sulph., 1 cwt. + Amm. sulph., 1 cwt.	298.0	412.9	483.4
Super., 2 cwt. + Lime, 30 cwt.	278.0	422.8	458.5
Super., 2 cwt. + Gypsum, 30 cwt.	355.4	416.1	479.8
No manure	358.0	376.2	359.1

Sheep-grazing data:—

Season.	Sheep-grazing. Days.	Sheep per Acre per Annum.
1927-28	5,978	6.55
1928-29	5,964	6.53

NOTE.—Season 1927-28 .. Manures applied 24th May, 1927.
Season 1928-29 .. Nitrate soda applied 13th June, 1928,
other manures 17th April, 1928.
Season 1931-32 .. Manures applied 20th April, 1931.



A crop of meadow hay taken from the plots in 1931.

hay-weights in column III. These show the plot yields from a magnificent crop of grass hay which developed in the south-west section of the field after two years of repeated close mowing. The last cut with the lawn-mower was made in May, 1931, a light grazing by sheep took place in June, another in August, and then the paddock was closed till the end of November. The accompanying illustrations show the crop, and are presented for the consideration of those who contend that the lawn-mowing method is unduly severe on the tall-growing species and invalidates the test. Whatever repression of grasses may be attributed to the mower, they have all been rehabilitated in the first season on both the manurial test plots and the rate and frequency of watering test plots.

It is not suggested that lawn-mowing imitates the grazing animal exactly, but the evidence derived from these tests is confirmed by extensive observation. In so far as nitrogenous manures are concerned the conclusions from mowing tests are conservative because the absence of animal droppings makes the draught on the nitrogen of the soil most severe, and the response to nitrogenous manures should be more marked.

The hay yields of 1931, which are complementary to the weights of grass clippings recorded, show that all the plots receiving fertilizer are in advance of the unmanured plots—the relative yields show the plots receiving super. only in a middle position, and plots getting super. supplemented with nitrogenous



Meadow hay crop, Werribee Research Farm.

manures or with potash show to best advantage. The conjunction of super., potash, and sulphate of ammonia was not beneficial. The explanation of these results is to be looked for in the selective action of the different manures on different species.

Mowing and Watering Technique.

The plots were mowed with a motor-mower, the green clippings were weighed; and composited samples were forwarded for chemical analysis, and periodical botanical surveys by means of the "percentage estimation" method were made. The details of these operations were similar to those described in the first report of this series. Within the limits imposed by the lay-out, and by the difficulties inherent in watering practice, the watering was uniform for all plots at each watering. As shown in Table 2, however, the waterings given during the two years of mowing (1929-30 and 1930-31) varied from $1\frac{1}{2}$ to 4 inches per acre. The main reason for adopting the "water-as-required" system was that the plots were, at first, mainly demonstrational, and it seemed desirable to conform to current practice; further, until the conclusion of the rate and frequency of watering tests, information on this point was insufficient.



Cutting a crop of meadow hay.

Experimental Design.

Although fifteen different manures or combinations of manures are included, as shown in Diagram 1, the lay-out is simple in design, since the plots were intended originally for observational and demonstrational purposes. Despite the shortcomings of the lay-out, the test has given much information which is sufficiently obvious in its implications to serve as a guide in defining better manurial practices, and it is with this idea in mind that these results, though not necessarily final, are discussed at this juncture. Excluding the part on the checkbanks, the individual plots are 3/55ths acre, at right angles to the checkbanks, which thus divide each plot into nine sections. Of each section, an area of 12 ft. x 22 ft. was mowed. The treatments include "No Manure," phosphatic, nitrogenous, and potash manures, and lime and gypsum.

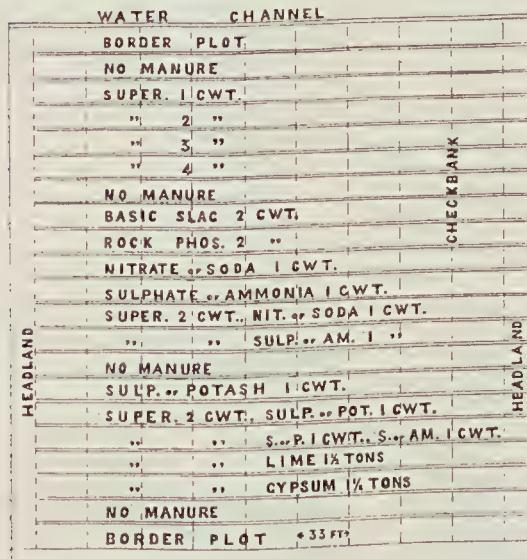


Diagram 1.—Showing the lay-out of the Manurial Test plots. On each Section an area 12 ft. by 22 ft. was mowed.

Total Yield.

Tables 3 and 4 show the total yields of dry matter in pounds per 3/55ths acre, the calculated "No Manure" values,* and the percentage increases over the "No Manure" values, for the seasons 1929-30 and 1930-31 respectively. Since these percentage increases cannot be

TABLE II.—SCHEDULE OF WATERINGS OF MANURIAL TESTS, S.W. SECTION, FIELD 2 S.W., DURING SEASONS 1929-30 AND 1930-31.

A. 1929-30 Season.

Date of Watering.	Amount Applied per Acre.	Number of Applications Required.
	Inches.	
10.9.29	2.00	1
4.10.29	2.17	1
14.10.29	2.00*	1
25.10.29-26.10.29	2.46	2
22.11.29	2.00	1
10.12.29-12.12.29	4.00	3
7.1.30-8.1.30	3.24	1
22.1.30	2.00	1
29.1.30-31.1.30	2.80	2
10.2.30-13.2.30	2.50	2
10.3.30-12.3.30	2.90	2
18.3.30	2.00	1
Total	28.07	

* = Bays 4, 5, and 6 only.

B. 1930-31 Season.

Date of Watering.	Amount Applied per Acre.	Number of Applications Required.
	Inches.	
19.9.30	2.25	1
10.10.30	2.00	1
29.10.30	2.07	1
18.11.30	2.10	1
22.12.30	2.50	1
9.1.31-10.1.31	3.60	2
31.1.31	1.83	1
6.2.31	1.50	1
12.2.31	1.84	1
19.2.31	1.84	1
17.3.31	2.00	1
Total	23.53	

accepted without some qualifying statement as to reliability, an attempt has been made, using the yields of dry matter obtained from the 36 sections of the four "No Manure" plots arranged in a block, to determine statistically the percentage difference in the yield of any plot, compared with the calculated "No Manure" value for that plot, which fulfills the standard requirement for the significance of a difference. The calculations involved are set out in Appendix 1, and show that differences of 10.2 and 10.7% of the calculated "No Manure" values are significant in the total yields of dry matter for seasons 1929-30 and 1930-31 respectively.

Before discussion of the percentage differences, the drop in yields in the 1930-31 season,

* On account of the lay-out, we are forced to assume, in order to make comparisons between widely-separated plots, that the change in yield of dry matter from one "No Manure" plot to the next would be gradual and uniform in nature. For example, the "No Manure" value of a plot midway between two "No Manure" plots giving a total yield of 1,000 lb. and 2,000 lb. respectively is, on the above assumption, 1,500 lb. If this manured plot actually yields 2,100 lb., it is assumed that of this yield 600 lb. is due to the manurial treatment.

TABLE III.—SHOWING YIELDS OF DRY MATTER IN POUNDS PER PLOT OF 3/55THS ACRE, AND PERCENTAGE INCREASES OVER CALCULATED "NO MANURE" VALUES, PASTURE MANURIAL TESTS, FIELD 2 S.W., S.W. SECTION, SEASON 1929-30.

Plot.	Yield of Dry Matter per 3/55th Acre.	Calculated "No Manure" Value.	Increase over Calculated "No Manure" Value.	Percentage Increase over Calculated "No Manure" Value.
	lb.	lb.	lb.	%
No manure ..	296.1			
Super., 1 cwt./ac. ..	459.1	307.5	151.6	49.3
Super., 2 cwt./ac. ..	559.7	318.9	240.8	75.4
Super., 3 cwt./ac. ..	661.2	330.4	330.8	100.1
Super., 4 cwt./ac. ..	720.0	341.8	378.2	110.7
No manure ..	353.2			
Basic slag, 2 cwt./ac. ..	569.9	369.8	200.1	54.1
Rock phos., 2 cwt./ac. ..	458.2	386.3	71.9	18.6
Nitrate of soda, 1 cwt./ac. ..	400.8	402.9	- 2.1	- 0.5
Amm. sulph., 1 cwt./ac. ..	425.1	419.4	5.7	1.4
Super., 2 cwt. + Nitrate soda, 1 cwt. ..	599.1	436.0	163.1	37.4
Super., 2 cwt. + Amm. sulph., 1 cwt. ..	582.4	452.5	129.9	28.7
No manure ..	469.1			
Pot. sulph., 1 cwt./ac. ..	449.2	473.3	- 24.1	- 5.1
Super., 2 cwt. + Pot. sulph., 1 cwt. ..	667.0	477.5	189.5	39.7
Super., 2 cwt. + Pot. sulph., 1 cwt. + Amm. sulph. ..	595.5	481.7	113.8	23.6
Super., 2 cwt. + Lime, 30 cwt. ..	685.8	485.9	199.9	41.2
Super., 2 cwt. + Gyp. sum, 30 cwt. ..	704.2	490.1	214.1	43.7
No manure ..	494.3			

A difference of 10.2 in the percentage increases over the calculated "No Manure" values is significant.

as compared with those of the 1929-30 season, calls for comment. The first cut of the 1929-30 season represented 143 days growth from 30th April, 1929, the date of the last grazing. If the dry matter from April to April in each season be compared, the "No Manure" plots and those not receiving superphosphate as a part of their manurial treatment, show a much greater decline in yield than those receiving superphosphate, either alone or in combination with other fertilizer.

Although the rate and frequency of watering plots, in every case, in the 1930-31 season showed a large increase over their 1929-30 totals, comparable plots in the manurial tests did not show such an increase. The probable reason is that the watering treatment being fixed in amount on the former plots, extra rainfall in the 1930-31 season, as compared with the 1929-30 season, would be expected to increase yields, particularly on plots normally receiving light or infrequent waterings. This has been shown to be the case (this Journal,

April, 1932). On the manurials, the total of rainfall and irrigation was almost the same in each season, and the production might be expected to be the same in each.

This reasoning does not explain the decreased yields of the "No Manure" plots, and those not receiving superphosphate, in the 1930-31 season. The fact that these particular plots are widely distributed over the field argues that it is not mere chance, but that phosphate deficiency is being expressed by lowered production. Assuming the average, P_2O_5 -content of "non-supered" herbage to be 0.60% (dry basis), the removal of 296.1 lb. dry matter from Plot 1 ("No Manure") by mowing in 1929-30 meant the removal of $0.60 \times 2.961 \times 55/3$, or 32.6 lb. P_2O_5 per acre. This amount represents a dressing of approximately $1\frac{1}{4}$ cwt. super. per acre. It is reasonable to suppose that a drain of this amount would seriously affect the vigour of the pasture. All the other plots showing a similar falling-off gave higher yields of dry matter than the plot quoted. It is also significant that the decline

TABLE IV.—SHOWING YIELDS OF DRY MATTER IN POUNDS PER PLOT OF 3/55THS ACRE, AND PERCENTAGE INCREASES OVER CALCULATED "NO MANURE" VALUES, PASTURE MANURIAL TESTS, FIELD 2 S.W., S.W. SECTION, SEASON 1930-31.

Plot.	Yield of Dry Matter per 3/55th Acre.	Calculated "No Manure" Value.	Increase over Calculated "No Manure" Value.	Percentage Increase over Calculated "No Manure" Value.
	lb.	lb.	lb.	%
No manure ..	191.6			
Super., 1 cwt./ac. ..	351.2	202.7	148.5	73.8
Super., 2 cwt./ac. ..	487.5	213.9	273.6	127.9
Super., 3 cwt./ac. ..	500.8	225.0	275.8	122.5
Super., 4 cwt./ac. ..	654.3	236.2	418.1	177.0
No manure ..	247.3			
Basic slag, 2 cwt./ac. ..	460.1	240.2	219.9	84.7
Rock phos., 2 cwt./ac. ..	345.1	251.0	94.1	37.5
Nitrate soda, 1 cwt./ac. ..	263.0	252.0	10.1	4.0
Amm. sulph., 1 cwt./ac. ..	272.0	254.7	17.3	6.8
Super., 2 cwt. + Nitrate soda, 1 cwt. per acre ..	506.9	256.6	250.3	97.5
Super., 2 cwt. + Amm. sulph., 1 cwt. per acre ..	493.5	258.5	235.0	90.8
No manure ..	260.3			
Pot. sulph., 1 cwt./ac. ..	269.4	263.0	6.4	2.4
Super., 2 cwt. + Pot. sulph., 1 cwt. ..	555.0	265.7	289.3	103.9
Super., 2 cwt. + Pot. sulph., 1 cwt. + Amm. sulph. ..	504.2	268.4	235.8	87.8
Super., 2 cwt. + Lime, 30 cwt. per acre ..	585.0	271.1	313.9	115.8
Super., 2 cwt. + Gyp. sum, 30 cwt. per acre ..	567.6	273.8	293.8	107.3
No manure ..	276.5			

A difference of 10.7 in the percentage increases over the calculated "No Manure" values is significant.

in yield shown by basic slag, rock phosphate, 1 cwt., 2 cwt., 3 cwt. and 4 cwt. super., are in the inverse order of their soluble- P_2O_5 content.

Summarizing the position we may say that, although the plots as a whole appear to have declined in productivity in the 1930-31 season, the apparent decline in the case of the plots treated with super. is not serious, owing to the longer period of growth represented by the 1929-30 totals, and in the case of the "non-supered" plots, it may be accounted for on the assumption that the removal of large amounts of P_2O_5 has not been compensated by applying an equivalent amount of super.

We may accept the total yields as given in Table 3, since inter-plot comparisons are not affected by the longer period represented by the 1929-30 season. Table 5 shows the nature of

TABLE V.—PASTURE MANURIAL TESTS. FIELD 2 S.W., S.W. SECTION, SEASONS 1929-30 AND 1930-31.

Showing the Nature of the Differences between the Total Yields of Dry Matter from the Various Manurial Treatments.

(Based on an Analysis of Variance of the 36 "No Manure" Sections.)

Plot Comparisons Made.	Nature of Difference.	
	1929-30.	1930-31.
<i>Compared with "No Manure"—</i>		
All plots receiving phosphatic manure, alone or in combination	Increase	Increase
All plots not receiving phosphatic manure	None	None
<i>Compared with "Superphosphate, 1 cwt."—</i>		
Basic slag, 2 cwt.	Increase	Increase
Rock phos., 2 cwt.	Decrease	Decrease
<i>Compared with "Superphosphate, 2 cwt."—</i>		
Basic slag, 2 cwt.	Decrease	Decrease
All plots receiving a combination of Super., 2 cwt. + one or more other manures	Decrease	Decrease
<i>Miscellaneous Comparisons—</i>		
Super., 2 cwt., compared with Super., 1 cwt.	Increase	Increase
Super., 3 cwt., compared with Super., 2 cwt.	Increase	Increase
Super., 4 cwt., compared with Super., 3 cwt.	Increase	Increase
Basic slag, 2 cwt., compared with Rock phos., 2 cwt.	Increase	Increase
Super., 2 cwt. + Nit. soda, compared with Super. + Amm. sulph.	None	None
Super., 2 cwt. + Pot. sulph., compared with Super. + Amm. sulph.	Increase	Increase
Super. + Pot. + Amm., compared with Super. + Amm. sulph.	None	None
Super. + Pot. + Amm., compared with Super. + Pot. sulph.	Decrease	Decrease
Super. + Lime, compared with Super. + Gypsum	None	None

the differences between the various plots in the two seasons, based on an analysis of the variance of the 36 "No Manure" plot-sections.*

The arrangement of Table 5 is such as to show as clearly as possible the relative merits of the various treatments, the field order of the plots being unsuitable for this purpose. The most important feature is the obvious supremacy shown by phosphatic manures in general, and by superphosphate in particular. All plots receiving super., whether alone or in conjunction with other manures, show a significant increase over "No Manure," while rock phosphate and basic slag are also significantly better than "No Manure." Further, in so far as superphosphate used alone is concerned, the limit of yield under the particular watering system used on these plots does not appear to have been reached even with the dressing of 4 cwt. super. per acre per annum, since the yield obtained with this dressing is significantly greater than that obtained with the 3 cwt. per acre per annum application. This great response of irrigated pasture herbage to phosphatic manuring has been recognized so long that the demonstration afforded by these results calls for little comment, except in so far as to stress the value of even more liberal manuring than the practice, which may be regarded as standard at present, of giving annual dressings of 2 cwt. per acre of superphosphate. In view of the intensive production necessitated by the high cost of irrigable land, the expenses incurred in the preparation of the ground and the establishment of permanent pastures, and the growing recognition of the potentialities of rotational grazing systems, the logical outcome is that the advantages of more liberal manuring will be quickly recognized and put into effect by the more progressive element of the irrigation communities. Possibly the white clover dominance which results from heavy phosphatic manuring may be regarded unfavorably by some dairymen because of its "bloating" propensities, but this defect without doubt can be largely eliminated by improved practice in the feeding-off of pastures of this type.

As might be expected, the less soluble phosphatic manures, rock phosphate and basic slag,

* Since the 36 sections of the four "No Manure" plots may be considered as a block of four rows, each of nine sections, an analysis of the variance of these gives the S.E. of a single section (12 feet x 22 feet) of any one of the "No Manure" plots, and the percentage S.E. of the total yield of dry matter from any "No Manure" plot is therefore S.E. percentage single section divided by $\sqrt{9}$. Since the distribution of the "No Manure" plots down the field is fairly good, it is assumed that they are a representative sample of the whole field considered on an unmanured basis. Manured plots are considered significantly different in yield when their percentage differences from their respective "No Manure" values differ by at least $2\sqrt{2}$ times the percentage S.E. of a single "No Manure" plot for that season.

are not as efficient, weight for weight, as superphosphate. Basic slag is significantly better than rock phosphate, owing to a higher percentage of phosphoric compounds readily soluble in the soil-water. The analysis of the basic slag used was:

Citrate-soluble P_2O_5	..	..	14.0%
Citrate-insol.	..	..	3.0%

Except for the phosphatic group, no *single* manure has given a significant increase in yield over "No Manure," and from the standpoint of annual production there is no evidence in support of the extravagant claims made for these other manures by those interested financially in their distribution. It is only fair to point out that most of these claims, particularly those made for ammonium sulphate and nitrate of soda, are made for these manures used in conjunction with a basic dressing of superphosphate; however, according to the table presented, the use of these with a basic dressing of 2 cwt. super. per acre has in every case resulted in a significant *decrease* in annual yield of dry matter as compared with 2 cwt. super. used alone. The results from the tests in 1931-32 suggest that this decrease does not always occur, but there is no evidence of increased production.

The only doubtful cases would appear to be lime and gypsum used with 2 cwt. super. per acre. Although in tests carried out on lucerne and pastures at the Werribee Research Farm, lime and gypsum have failed to give increased yields, and in this test a decrease has resulted from their use, it must be stated that extensive liming operations were carried out on the farm shortly after its establishment, and the Manurial Field is now uniformly and highly alkaline (pH 7.7). From the evidence of these tests, it is impossible to make any definite pronouncement in regard to the value of either lime or gypsum applied to irrigated pastures on soils of a different reaction.

With regard to nitrogenous manures, additional evidence has been obtained from a separate series of tests, and it has been established that the benefits from them are to be obtained only at certain restricted times of the year, and are then only temporary in character.

The relationship of the various mixtures of superphosphate, nitrogenous manures, and potash sulphate is of interest. In the first place, there is no significant difference between "Super. 2 cwt. + Nitrate of Soda 1 cwt." per acre and "Super. 2 cwt. + Ammonium sul-

phate 1 cwt." per acre, whereas "Super. 2 cwt. + Potash sulphate 1 cwt." shows a significant increase over "Super. 2 cwt. + Ammonium sulphate 1 cwt.," but not over "Super. 2 cwt. + Nitrate of Soda 1 cwt." The addition of "Ammonium sulphate 1 cwt." to the "Super. 2 cwt. + Potash sulphate 1 cwt." combination removes the advantage which the latter possessed over "Super. 2 cwt. + Ammonium sulphate 1 cwt.," since the Table shows that a significant difference no longer obtains. In a similar manner the addition of "Ammonium sulphate 1 cwt." to the "Super. 2 cwt. + Potash sulphate 1 cwt." combination caused a significant drop in yield as compared with "Super. 2 cwt. + Potash sulphate 1 cwt." alone. These results open up an interesting field in regard to the interaction of various manures, and emphasize the necessity for careful experimentation with manure combinations instead of assuming that the result to be obtained from a mixture of manures, "A" and "B" will be the sum of the results obtained by the uses of "A" and "B" singly. There would appear to be more involved in manurial practice than the primary function of supplying those elements most deficient in the soil, and it may even be that a slight excess of any one element is far more detrimental than a deficiency of that element. For the investigation of problems of this kind, the type of layout represented by this series of tests is inadequate, and to pursue inquiries of this nature a new set of plots, featuring the principles of experimental design advocated by R. A. Fisher and J. Wishart ("The arrangement of field experiments and the statistical reduction of the results," Tech. Comm. No. 10. Imper. Bur. Soil Sci. May, 1930), has been instituted.

The main points brought out in these tests, from the standpoint of total yield of dry matter may be summarized as follows:—

(1) Superphosphate is pre-eminent as a fertilizer for irrigated pastures of which the main constituents are perennial ryegrass, cocksfoot, and white clover.

(2) Nitrogenous manures and potash fail to show promise, whether used alone or with superphosphate.

(3) Lime and gypsum do not show benefits, *but this may be due to previous treatment of the experimental field.*

(4) The limit of production, under the watering system employed, apparently was not reached with 4 cwt. super. per acre per annum.

(5) The efficiency of the phosphatic manures is determined by their readily-available- P_2O_5 content.

(6) The P_2O_5 annually removed from the "No Manure" and other plots not receiving phosphatic manure, by the mowing, is regarded as the major cause of the declining yield of those plots.

(7) The need for improved lay-out, for the investigation of the finer details of manurial problems, such as the interaction of manures in combination, is indicated.

Distribution of the Yield.

It is of interest, before making interplot comparisons, to compare the yield-distribution of the "2-cwt. superphosphate" plot on the Manurial Field with that of the plot receiving 6 waterings of 4" on the Rate and Frequency of Watering Field, provided the difference in the watering methods employed is not lost sight of. From the nature of the distribution of the yield on the watering tests it was inferred that "the production of an irrigated pasture seems to be characterized by three peak-periods—one in spring, one in midsummer, and one in autumn—the times of occurrence of these being determined by the times of occurrence of the seasonal rains." The graphs of the Manurial plots indicate that the peaks in midsummer and autumn are largely determined by the disposition of the irrigation in relation to rainfall: if optimum soil-moisture conditions are maintained during this period these two peaks may be merged into one. There is as yet no evidence that the depression of growth following the peak produced by the spring flush may be similarly eliminated. The yields of the various plots at each cut are given in Table 6.

In order to differentiate between those differences due to soil and water variation, and those due to the manures applied, an analysis of the variance of the yields of dry matter of the 36 sections of the four "No Manure" plots has been made for each cut. To simplify the process of comparison of related plots, various groupings of plots are shown in Table 7 with the nature of the differences shown by them from cut to cut.

Where differences are significant they are designated "+" or "-" respectively; where a difference is not significant it is designated "p" or "n" according to whether it is positive or negative in relation to the standard plot temporarily employed. The latter classification is

very useful in demonstrating the trend of changes in production-rate, e.g., the "Super. and Lime" plot, in season 1930-31, shows the following differences from "Super. 2 cwt.," in the order of successive cuts: — — n n p + + + + n —, thus demonstrating the gradual improvement of the "Super. and Lime" plot until it is significantly better than "Super. 2 cwt.," after which it again declines.

The outstanding superiority of the phosphatic manures in raising the production-rate throughout the year is obvious from the comparisons made with "No Manure"; further, since rock phosphate shows a positive, but not significant difference from "No Manure" at five cuts, it is apparent that the efficiency of a phosphatic manure in the above respect is governed by its available- P_2O_5 content. In agreement with the law of diminishing returns the relative efficiency per cwt. of super. applied diminishes as the annual dressing is increased. Thus,

while 1 cwt. super. is significantly better than "No Manure" at 22 cuts;

while 2 cwt. super. is significantly better than 1 cwt. super. at 17 cuts;

while 3 cwt. super. is significantly better than 2 cwt. super. at 17 cuts;

and 4 cwt. super. is significantly better than 3 cwt. super. at 6 cuts.

The totals of "+" and "p" differences are much the same, however:

2 cwt.: 1 cwt., 19

3 cwt.: 2 cwt., 20

4 cwt.: 3 cwt., 18, indicating a raising of yield over the greater part of the year with 4 cwt. as compared with 3 cwt.

On two occasions (1st cut, 1/9/30, and 2nd cut, 1/10/30) 4 cwt. super. gave significantly lower yield than 3 cwt., due probably to its botanical composition (the percentage of white clover was consistently higher on the 4 cwt. plot than on the 3 cwt., and the subterranean clover percentage lower. The amount of grass and subterranean clover present was not sufficient to give at this spring period a yield equal to that of the 3 cwt. plot). (See Botanical Composition). The basic slag, in comparison with "Super. 2 cwt.," shows this feature more definitely, four cuts being effected (11th in 1929-30, and 1st, 2nd, 3rd in 1930-31). The value of winter feed to dairymen renders this feature particularly important in manurial practice, demonstrating as it does that it is more profitable to use 2 cwt. super., and thereby to increase production all the year round,

than it is to use a similar dressing of basic slag or other less-soluble phosphatic fertilizer. Rock phosphate, in comparison with "Super. 1 cwt.," gave significantly lower yield in thirteen cuts, and "n" differences in another five cuts, further emphasizing this point.

It will be noted that the efficiency of the 4 cwt. super. dressing, as compared with 3 cwt., is greatest at cuts 7 and 11 in 1929-30, and cuts 7, 8, 9, 10 in 1930-31. Cut 11 in 1929-30 represents winter production, while the remaining cuts were taken off during periods when

PASTURE MANURIAL TESTS.—FIELD No. 2, S.W.—SEASONS 1929-30 AND 1930-31.

TABLE VI.—YIELDS OF DRY MATTER PER PLOT OF 0.0545 ACRE.

A. 1929-30.

Cut No.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Date of Cutting	17-30 Sept., 1929.	15-18 Oct., 1929.	7-8 Nov., 1929.	29-4 Nov., 1929.	24-31 Dec., 1929.	13-15 Jan., 1930.	4-6 Feb., 1930.	25-27 Feb., 1930.	18-20 Mar., 1930.	14-16 Apr., 1930.	25-26 June, 1930.
TREATMENT.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
No manure	50.0	37.9	27.5	20.8	49.7	25.9	24.3	23.9	16.7	15.0	4.4
Super., 1 cwt. per acre	78.9	54.0	38.9	42.3	73.0	39.8	30.1	37.5	26.0	21.5	10.7
Super., 2 cwt. per acre	78.6	55.1	38.9	48.6	86.6	49.4	60.9	53.7	37.8	31.2	18.9
Super., 3 cwt. per acre	89.4	54.9	40.4	57.1	99.3	57.2	79.1	66.3	48.2	44.9	24.2
Super., 4 cwt. per acre	90.2	56.9	43.7	64.6	106.4	61.0	94.7	72.9	52.6	50.0	27.0
No manure	53.8	42.8	30.0	28.3	57.1	31.0	31.7	34.5	20.9	18.4	4.7
Basic slag, 2 cwt. per acre	91.6	55.1	42.5	51.2	80.2	49.7	66.4	54.3	37.4	31.1	10.4
Rock phos., 2 cwt. per acre	74.5	47.2	36.3	35.2	70.4	39.5	47.6	45.2	31.1	25.4	6.7
Nitrate of soda, 1 cwt. per acre	78.3	45.7	34.4	27.3	56.5	32.1	38.3	37.3	29.9	18.6	9.4
Amm. sulph., 1 cwt. per acre	96.3	43.8	33.6	31.0	58.8	32.6	37.7	38.8	23.7	19.6	9.2
Super., 2 cwt. per acre + Nitrate of soda, 1 cwt. per acre	124.9	47.1	39.7	43.8	80.8	46.7	66.7	54.5	38.7	32.4	23.8
Super., 2 cwt. per acre + Amm. sulph., 1 cwt. per acre	128.2	46.3	37.9	41.0	74.9	45.3	63.7	52.5	36.9	32.8	22.9
No manure	95.3	51.6	38.5	36.9	68.6	37.5	45.7	43.2	26.5	20.6	4.7
Pot. sulph., 1 cwt. per acre	93.1	52.9	38.8	36.4	65.5	35.1	43.7	43.4	24.1	19.0	6.2
Super., 2 cwt. per acre + Pot. sulph., 1 cwt. per acre	118.5	57.7	46.8	57.7	92.6	51.2	79.2	62.7	42.5	33.9	24.2
Super., 2 cwt. per acre + Pot. sulph., 1 cwt. per acre + Amm. sulph., 1 cwt. per acre	120.4	51.7	40.4	44.3	78.1	44.3	65.1	55.5	38.0	33.9	23.8
Super., 2 cwt. per acre + Lime 30 cwt. per acre	112.8	57.4	44.6	56.2	92.6	56.7	86.2	64.9	47.3	42.3	24.8
Super., 2 cwt. per acre + Gypsum 30 cwt. per acre, 1 cwt. per acre	120.2	61.9	55.2	60.2	90.5	57.6	85.9	63.9	44.5	40.8	23.5
No manure	103.2	61.3	44.7	41.0	71.2	37.7	42.4	40.8	23.0	21.2	7.8

B. 1930-31.

Cut No.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Date of Cutting	1-3 Sept., 1930.	1-2 Oct., 1930.	21-23 Oct., 1930.	11-12 Nov., 1930.	4-11 Dec., 1930.	5-7 Jan., 1931.	29-30 Jan., 1931.	17-18 Feb., 1931.	10-11 Mar., 1931.	13-16 Apr., 1931.	21-23 May, 1931.
TREATMENT.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
No manure	20.2	11.2	36.1	19.6	26.4	24.7	11.6	8.7	5.7	11.5	15.9
Super., 1 cwt. per acre	52.9	36.2	66.0	27.4	42.6	42.6	15.3	11.9	9.4	16.4	30.6
Super., 2 cwt. per acre	64.5	52.9	79.0	39.1	64.0	66.0	25.7	16.9	16.2	26.3	36.9
Super., 3 cwt. per acre	68.5	54.2	82.8	44.0	78.9	82.1	39.4	28.2	26.2	43.0	43.5
Super., 4 cwt. per acre	65.8	51.0	84.8	47.5	83.6	80.9	48.0	41.9	37.8	55.7	48.3
No manure	22.8	15.7	50.4	21.1	32.3	34.7	15.4	11.9	7.4	15.5	20.1
Basic slag, 2 cwt. per acre	47.6	37.3	74.7	37.6	59.9	68.0	28.8	22.0	19.4	28.5	36.3
Rock phos., 2 cwt. per acre	33.6	22.0	58.4	27.6	43.7	51.8	22.1	17.7	16.7	21.6	29.9
Nitrate of soda, 1 cwt. per acre	26.4	15.3	46.2	21.6	33.8	36.9	17.8	12.9	8.9	16.1	24.1
Amm. sulph., 1 cwt. per acre	26.0	15.6	45.4	27.1	36.7	41.2	19.0	13.8	9.5	15.9	21.8
Super., 2 cwt. per acre + Nitrate of soda, 1 cwt. per acre	57.8	40.6	72.2	42.0	67.3	73.2	37.5	26.5	22.5	29.6	37.7
Super., 2 cwt. per acre + Amm. sulph., 1 cwt. per acre	57.0	38.3	67.0	41.1	65.2	73.6	37.4	26.0	24.8	28.6	34.5
No manure	25.7	16.0	49.2	24.3	34.6	35.4	17.4	10.8	7.6	16.3	23.0
Pot. sulph., 1 cwt. per acre	24.6	15.5	53.4	23.5	35.1	37.8	19.5	12.0	9.4	16.6	22.0
Super., 2 cwt. per acre + Pot. sulph., 1 cwt. per acre	69.0	47.7	83.0	41.9	69.6	81.2	40.1	28.7	24.3	29.3	40.2
Super., 2 cwt. per acre + Pot. sulph., 1 cwt. per acre + Amm. sulph., 1 cwt. per acre	58.5	39.2	70.8	39.1	67.6	77.8	37.9	27.4	24.1	20.9	34.9
Super., 2 cwt. per acre + Lime 30 cwt. per acre	58.6	47.3	81.9	48.5	75.6	83.8	49.8	35.0	31.0	34.8	38.7
Super., 2 cwt. per acre + Gypsum 30 cwt. per acre, 1 cwt. per acre	65.0	43.5	81.0	48.4	71.7	78.0	47.2	30.6	27.0	29.1	37.5
No manure	30.1	19.4	52.3	26.2	32.7	32.5	21.9	13.2	8.9	16.5	22.8

TABLE VII.—SHOWING THE NATURE OF THE DIFFERENCES IN YIELD OF DRY MATTER FROM THE VARIOUS PLOTS AT EACH CUT, PASTURE MANURIAL TESTS, FIELD 2 S.W., S.W. SECTION, SEASONS 1929-30 AND 1930-31.

(Based on the Analysis of the Variance of the 36 Sections of the Four "No Manure" Plots at each Cut.)

Plot Comparison Made.	Nature of Difference in Yield of Dry Matter at Cut Number.																						Analysis of Differences for the Two Seasons.					
	(Season 1929-30.)											(Season 1930-31.)																
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	+	p	n	-	Total.	
With "No Manure."																												
Plots receiving super. alone ..	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	22	..	..	..	22		
Basic slag ..	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	22	..	..	..	22		
Rock phosphate ..	p	p	p	p	+	+	+	+	+	+	+	+	+	p	+	+	+	+	+	+	+	17	5	..	..	22		
Nitrate of soda ..	p	n	p	n	n	n	p	n	n	+	n	+	p	n	p	p	p	p	p	p	p	2	13	7	..	22		
Amm. sulph. ..	+	n	n	n	n	n	n	n	n	+	n	+	p	n	p	+	+	+	+	+	+	3	6	12	..	22		
Pot. sulph. ..	n	u	n	n	n	n	n	p	n	n	+	+	p	n	p	p	p	+	p	p	p	2	7	13	..	22		
With Superphosphate 1 cwt./ac.																												
Basic slag ..	n	-	p	n	n	p	+	p	+	n	-	-	-	+	+	+	+	+	+	+	n	10	3	4	5	22		
Rock phosphate ..	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	n	1	3	5	13	22		
Nitrate of soda ..	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	p	n	n	n	-	-	..	..	2	20	22		
Amm. sulph. ..	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	..	..	1	21	22		
Pot. sulph. ..	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	n	n	-	-	-	1	..	1	20	22		
With Superphosphate, 2 cwt./ac.																												
Super., 2 cwt. + Nitrate of soda ..	n	-	-	-	-	-	-	-	-	+	-	-	n	n	-	-	+	+	+	+	n	-	4	..	4	14	22	
Super., 2 cwt. + Amm. sulph. ..	n	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	+	+	+	-	-	4	..	1	17	22	
Super., 2 cwt. + Pot. + Amm. sulph. ..	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	n	n	+	+	-	-	2	..	2	18	22		
Super., 2 cwt. + Pot. sulph. ..	-	-	-	-	-	-	-	-	-	-	p	-	-	p	-	p	p	+	+	-	-	2	4	..	16	22		
Super., 2 cwt. + Lime ..	-	-	-	-	-	-	-	-	n	p	-	-	-	n	n	p	+	+	+	+	p	4	3	3	12	22		
Super., 2 cwt. + Gypsum ..	-	-	n	-	-	-	-	-	-	p	-	-	-	n	n	n	+	+	+	+	-	4	3	4	13	22		
Miscellaneous.																												
Super., 2 cwt., compared with Super., 1 cwt. ..	n	n	p	p	+	+	+	+	+	+	+	+	+	n	+	+	+	+	+	+	+	17	2	3	..	22		
Super., 3 cwt., compared with Super., 2 cwt. ..	+	n	p	+	+	+	+	+	+	+	+	p	n	+	p	+	+	+	+	+	+	17	3	2	..	22		
Super., 4 cwt., compared with Super., 3 cwt. ..	n	p	p	p	p	p	+	p	p	p	+	-	-	n	p	p	p	+	+	+	p	6	12	2	2	22		
Basic slag, 2 cwt., compared with Super., 2 cwt. ..	p	-	n	-	-	-	-	-	-	-	-	-	-	-	-	-	n	p	p	n	-	..	3	3	16	22		
Basic slag, 2 cwt., compared with Rock phosphate ..	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	22	..	..	..	22		
Super. + Lime, compared with Super. + Gypsum ..	n	n	-	n	p	n	n	p	p	p	+	-	p	n	p	p	p	+	+	+	+	p	5	9	6	2	22	
Super. + Pot., compared with Super. + Amm. ..	-	+	+	+	+	+	+	+	+	p	-	+	+	+	n	+	+	n	p	n	p	+	14	3	3	2	22	
Super. + Pot., compared with Super. + Pot. + Amm. ..	+	p	p	p	p	p	n	n	p	n	+	+	p	n	+	-	-	+	p	+	p	p	6	10	4	2	22	

NOTE. — + = Significant increase. — = Significant decrease. p = Increase (not significant). n = Decrease (not significant).

continued dry weather rendered it difficult to maintain optimum soil-moisture conditions. The role of the superphosphate in maintaining the production-rate at a high figure during those periods when unmanured pasture is suffering from dry conditions is important, especially in areas where it is not always possible to obtain water immediately as required.

In comparison with "No Manure," the efficiency of nitrate of soda and ammonium sulphate is seen to be largely dependent on seasonal conditions at the time of application. It is obvious that no great benefit is to be derived from them beyond a temporary increase in yield in winter or autumn. The fact that *only one time of application* was under test in this series limits the amount of information which can be obtained, and it is proposed to deal more fully with nitrogenous manures in a report on a series of tests now being carried out. Used with super. 2 cwt., they again show the above features, accentuated in regard to the magnitude of the positive and negative changes in production-rate as compared with super. 2 cwt. alone, at corresponding periods. It is, therefore, a question of farm economics whether the value of the increased production at these periods represents a profitable investment, and it is a question which must be answered by the individual concerned, no general statement being applicable to the wide range of conditions which occur in practice.

Potash sulphate, used alone or with 2 cwt. super., may be placed in the same category. Lime and gypsum with 2 cwt. super. show up poorly against 2 cwt. super. alone. While they show significant increases over super. 2 cwt. at the same periods as nitrogen and potash in both seasons, these increases are not comparable in value with those obtained by the application of an extra cwt. superphosphate.

These points are summarized below:—

(1) Phosphatic manures showed the greatest all-the-year-round efficiency in raising the production-rate of an irrigated pasture at Werribee, the relative efficiency of the fertilizer being governed by its readily-available- P_2O_5 content.

(2) Superphosphate is relatively most efficient during those periods when growth on unmanured pasture is severely handicapped by adverse conditions, such as dryness in summer or low temperatures in winter.

(3) With the heavier dressings of super., the production per cwt. of manure applied

decreased, but the limit of production on this type of pasture was obviously not reached, even with 4 cwt. super. per annum, under the watering system employed.

(4) Nitrogenous manures stimulated out-of-season growth for a short period, but did not raise production for the majority of cuts.

(5) Potash sulphate, lime, and gypsum, in combination with super. 2 cwt., did not profitably alter the yield-distribution.

Botanical Composition.

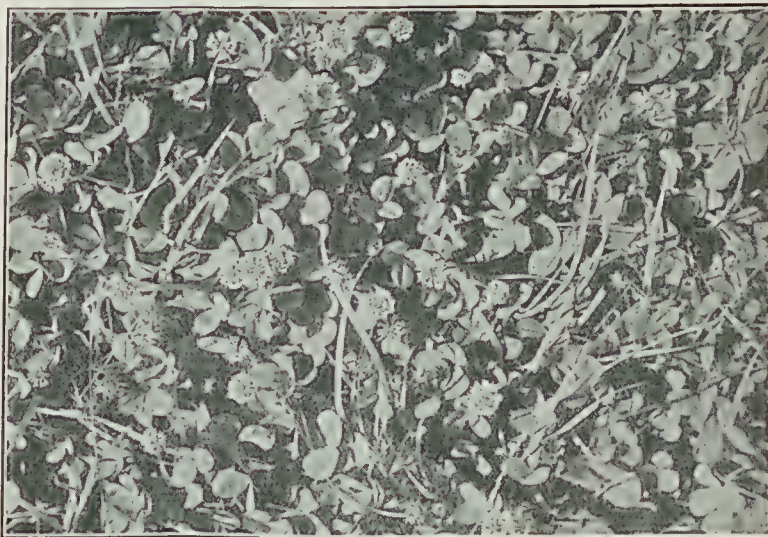
Table 8 (Section A) shows the mean percentages of white, strawberry clover, subterranean clover, rye-grass, and cocksfoot as determined by a series of botanical surveys by the "percentage estimation" method during the period 1929-31. The 4-sq. links mesh was used, 10 estimations being made on each section of a plot in three adjacent bays. While these figures are not to be regarded as absolute, they present a reliable comparison, and the conclusions derived from them are supported by observation.

In Section B of Table 8, a series of ratios derived from the mean percentages of Section A is given, to facilitate comparisons of the various treatments. Since the clover-grass ratio is much the same for the four "No Manure" plots, the ratios of these two species-groups under varied manuring should be comparable without adjustment. In all cases where super. was applied, except "Super. and Lime," the clover-grass ratio was raised, and this increase was progressive until with 4 cwt. super. the ratio was double that of the "No Manure" plots. Basic slag occupied a position between super. 1 cwt. and super. 2 cwt., while rock phosphate caused very little change. Nitrogenous manures depressed the clover-grass ratio, and in conjunction with super. limited the increases normally occurring with super. alone. Potash used alone had very little effect, but in conjunction with super. and ammonium sulphate produced a marked decrease in the clover-grass ratio.

Considering the grasses alone: The ratio of cocksfoot to rye-grass increased down the bays on the "No Manure" plots, which rendered the decreases due to super. applications more definite. Basic slag appeared to favour cocksfoot more than would be expected from a consideration of its available- P_2O_5 content. Nitrogenous manures, alone and with super., depressed the ratio.

Considering the clovers alone: The ratio of white clover to subterranean clover

decreased down the bays on the "No Manure" plots, so that the increases due to super. are more conclusive. The sudden increase from 3 cwt. to 4 cwt. is noteworthy, and was a feature of the plots in the North-west section. In proportion to its available- P_2O_5 content, basic slag maintains a very high white-subterranean ratio. Nitrate of soda and ammonium sulphate differ considerably, the ammonium sulphate having considerably raised the ratio when used alone. However, there is evidence from the North-west section that these effects (of nitrogenous manures) are not consistently produced.



Irrigated Pasture at Werribee, showing Rye grass, Prairie grass, and White clover.

TABLE VIII.

SECTION A.—SHOWING THE MEAN ESTIMATED PERCENTAGES OF MAJOR SPECIES COMPRISING THE HERBAGE, PASTURE MANURIAL TESTS, FIELD 2 S.W., S.W. SECTION, 1929-30 AND 1930-31.
Means of Eight Surveys (Bays 7, 8, and 9).

SECTION B.—SPECIES RATIOS ON VARIOUS PLOTS IN PASTURE MANURIAL TESTS, FIELD 2 S.W., S.W. SECTION, SEASONS 1929-30 AND 1930-31.
(Derived from Mean Percentages of Section A.)

Section A.

Section B.

Plot.	Mean Percentage of—					Ratio of—		
	Rye-grass.	Cocks-foot.	White Clover.	Subterranean Clover.	Bare Space.	Total Valuable Clovers to Total Valuable Grasses.	Cocksfoot to Ryegrass.	White Clover to Subterranean Clover.
No manure	7.5	30.4	48.7	4.7	12.1	1.41	4.05	10.36
Super., 1 cwt.	5.7	22.5	60.9	5.5	5.6	2.35	3.95	11.07
Super., 2 cwt.	5.9	20.1	64.9	5.7	5.1	2.72	3.41	11.38
Super., 3 cwt.	5.8	18.5	66.6	5.5	4.5	2.97	3.19	12.12
Super., 4 cwt.	6.0	17.7	71.0	2.9	3.9	3.12	2.95	24.47
No manure	5.7	29.8	50.4	8.9	9.3	1.67	5.23	5.67
Basic slag, 2 cwt.	5.0	22.8	64.9	5.5	5.4	2.53	4.56	11.80
Rock phos., 2 cwt.	5.6	27.5	55.9	7.9	7.3	1.93	4.91	7.08
Nitrate soda, 1 cwt.	7.9	37.5	44.5	6.1	11.4	1.11	4.75	7.29
Amm. sulph., 1 cwt.	8.3	36.7	48.5	3.9	10.6	1.16	4.42	12.44
Super., 2 cwt., and Nitrate soda, 1 cwt.	8.8	21.6	60.0	7.5	6.6	2.22	2.46	8.00
Super., 2 cwt., and Amm. sulph., 1 cwt.	8.5	21.9	62.1	5.3	7.0	2.22	2.58	11.72
No manure	4.4	32.4	51.0	9.2	9.4	1.64	7.37	5.54
Pot. sulph., 1 cwt.	4.7	36.3	44.9	8.6	10.8	1.30	7.72	5.22
Super., 2 cwt., and Pot. sulph., 1 cwt.	5.9	25.8	57.0	9.2	6.6	2.09	4.38	6.20
Super., 2 cwt., Pot. sulph., Amm. sulph.	9.6	29.7	51.2	4.8	9.7	1.43	3.09	10.66
Super., 2 cwt., and Lime, 30 cwt.	8.0	31.6	52.7	3.2	11.6	1.41	3.95	16.47
Super., 2 cwt., and Gypsum, 30 cwt.	5.2	26.8	59.4	4.7	8.2	2.00	5.15	12.64
No manure	4.8	34.0	46.3	10.0	11.7	1.45	7.08	4.63



Intensively grazed irrigated pasture at Werribee. This pasture, which is growing on a heavy clay loam, is 17 years old. Perennial rye grass, Kentucky Blue, Cocksfoot, White Clover, and Strawberry Clover comprise the sward.

The "bare space" figures given in Section A of Table 8 show the average percentage of ground surface not covered by herbage, and these also demonstrate a feature of phosphatic manuring which is important in irrigation areas. The reduction in "bare space" which follows phosphatic manuring greatly reduces losses by evaporation, and the tests have shown that, taking the results cut by cut, there is a high negative correlation ($r = -0.8$) between yields of herbage and estimated "bare space" percentages. Nitrogenous and other manures tend to increase the average "bare space" percentage.

In Table 9 the actual weights of *each species* produced on the plot are given. The main features of this table may be summarized as follows:

(1) *In comparison with "No Manure":*

(a) Super. alone, basic slag, and rock phosphate raise the production of the four major species—rye-grass, cocksfoot, white clover, and subterranean clover.

(b) Nitrate of soda, ammonium sulphate, and potash sulphate, if they effect any change at all, lower the production of white clover and subterranean clover, and raise the production of rye-grass and cocksfoot.

(2) *In comparison with "Super. 2 cwt.":* the combinations which included 2 cwt. super. raised the production of rye-grass and cocksfoot, and lowered the production of white clover. While the reaction of white clover, whether positive or negative, to a manure, is always marked in an irrigated pasture, that of the grasses is of a comparatively low order, and for this reason varying results are obtained with certain manurial treatments because of the initial botanical composition of the pasture. It is apparent that a pasture in which grasses (particularly rye-grass) are dominant, are likely either to give an increased yield with nitrogenous manures, or alternatively to be affected but slightly, whereas one in which clover is dominant is likely to show considerably

TABLE IX.—ESTIMATED AMOUNT OF DRY MATTER CONTRIBUTED BY THE MAJOR SPECIES AT EIGHT SURVEYS, PASTURE MANURIAL TESTS, FIELD 2 S.W., S.W. SECTION, SEASONS 1929-30 AND 1930-31.

Plot.	Pounds of Dry Matter per 1/55th Acre Contributed by—					
	Rye-grass.	Cocksfoot.	White Clover.	Subterranean Clover.	Total Valuable Grasses.	Total Valuable Clovers.
No manure ..	3.0	14.0	26.2	4.7	17.0	30.9
Rock phos., 2 cwt. ..	4.6	18.3	40.6	7.8	22.9	48.4
Super., 1 cwt. ..	4.4	18.4	51.1	9.7	22.8	60.8
Basic slag, 2 cwt. ..	5.4	20.9	64.4	10.1	26.3	74.5
Super., 2 cwt. ..	6.6	23.2	76.1	14.5	29.8	90.6
Super., 3 cwt. ..	7.4	26.2	93.4	19.7	33.6	113.1
Super., 4 cwt. ..	8.9	28.0	113.1	18.0	36.9	151.1
Nitrate of soda, 1 cwt. ..	5.6	20.5	25.2	4.1	26.1	29.3
Amm. sulph., 1 cwt. ..	5.1	17.7	26.0	3.5	22.8	29.5
Pot. sulph., 1 cwt. ..	3.4	15.5	22.8	4.3	18.0	27.1
Super., 2 cwt., and Nitrate soda, 1 cwt. ..	12.1	21.7	60.6	11.0	33.8	71.6
Super., 2 cwt., and Amm. sulph., 1 cwt. ..	11.5	20.1	61.0	9.0	31.6	70.0
Super., 2 cwt., Amm. sulph., 1 cwt., and Pot. sulph. ..	10.4	23.3	46.2	6.9	33.7	53.1
Super., 2 cwt., and Pot. sulph., 1 cwt. ..	7.8	22.0	52.4	10.4	29.8	62.8
Super., 2 cwt., and lime, 30 cwt. ..	9.5	27.0	54.3	8.4	37.1	62.7
Super., 2 cwt., and Gypsum, 30 cwt. ..	6.7	24.2	64.0	8.7	30.9	72.7

NOTE.—Above weights adjusted to an "average No Manure" basis.

reduced yields under such manuring. This view is supported by the results of the manurial tests on the North-west section, the results from which have been published in the *State Research Farm Guide Book* for 1932—this section has a much higher grass percentage than the South-west section where the tests described have been carried out.

It must be remembered that the preceding summary of the effects of manuring on species-productivity apply only to those species when in association with others in pasture, and that it is intended here to state the effects only; the action of the manure may be direct, as a plant food, in some cases, and indirect, as a selective influence on species-competition, in others. For example, while nitrogenous manures might perhaps be beneficial to white clover when grown alone, they are invariably detrimental to its growth in a pasture.

Chemical Composition.

During the 1929-30 season composite samples of the herbage from the various plots were forwarded to the Departmental Laboratories for moisture determination (as received), and analysis of the dry matter in respect of its feeding value. Protein, fibre, silica, and silica-free ash were determined by standard methods, and carbohydrate plus fat by difference. The samples for the seventh cut were not analysed.

Table 10 shows the lime (CaO) and phosphoric acid (P_2O_5) contents of the herbage

TABLE X.—LIME (CaO) AND PHOSPHORIC ACID (P_2O_5) CONTENTS OF HERBAGE, FIRST CUT, PASTURE MANURIAL TESTS, FIELD 2 S.W., S.W. SECTION, SEASON 1929-30.

(On Dry Basis.)

Plot.	CaO.	P_2O_5 .
No manure	·73	·73
Super., 1 cwt.	·96	·92
Super., 2 cwt.	1·08	1·03
Super., 3 cwt.	·93	1·10
Super., 4 cwt.	1·05	1·10
No manure	·87	·75
Basic slag, 2 cwt.	·94	·84
Rock phos., 2 cwt.	·88	·84
Nitrate of soda, 1 cwt.	·72	·67
Amm. sulph., 1 cwt.	·49	·63
Super., 2 cwt., and Nitrate of soda, 1 cwt.	·58	·91
Super., 2 cwt., and Amm. sulph., 1 cwt.	·49	·93
No manure	·56	·65
Pot. sulph., 1 cwt.	·75	·75
Super., 2 cwt., and Pot. sulph., 1 cwt.	·72	1·02
Super., 2 cwt., Pot. sulph., 1 cwt., and Amm. sulph.	·57	·96
Super., 2 cwt., and Lime, 30 cwt.	·94	·94
Super., 2 cwt., and Gypsum, 30 cwt.	1·21	·97
No manure	·68	·59

TABLE XI.—WEIGHTED AVERAGE COMPOSITION, ETC., OF EACH PLOT (DRY BASIS), PASTURE MANURIAL TESTS, FIELD 2 S.W., S.W. SECTION, SEASON 1929-30.

(Exclusive of Seventh Cut.)

Plot.	Protein.	Crude Fibre.	Carbo-hydrate, plus Fat.	Silica Free Ash.	Calories per 100 gm.	Nutritive Ratio.
No manure	21·8	18·2	47·2	7·5	276	(1·—)
Super., 1 cwt.	24·8	17·0	45·9	8·4	283	2·7
Super., 2 cwt.	27·3	16·2	44·1	9·3	283	2·3
Super., 3 cwt.	26·9	16·3	44·4	9·4	285	2·4
Super., 4 cwt.	28·0	16·0	43·6	9·6	286	2·3
No manure	23·7	17·4	47·1	8·3	283	2·9
Basic slag, 2 cwt.	26·5	16·3	45·2	9·2	287	2·5
Rock phos., 2 cwt.	24·9	17·3	46·1	8·8	284	2·7
Nitrate Soda, 1 cwt.	22·6	18·2	47·4	8·2	280	2·0
Amm. sulph., 1 cwt.	22·5	18·6	48·4	7·9	284	2·1
Super., 2 cwt., and Nitrate soda, 1 cwt.	25·3	17·7	45·0	8·7	281	2·6
Super., 2 cwt., and Amm. sulph., 1 cwt.	24·6	18·0	45·2	9·1	279	2·7
No manure	25·3	17·5	45·6	8·5	284	2·6
Pot. sulph., 1 cwt.	25·4	18·2	46·2	9·0	286	2·7
Super., 2 cwt., and Pot. sulph., 1 cwt.	25·7	17·9	43·8	9·5	278	2·5
Super., 2 cwt., Pot. sulph., Amm. sulph.	24·5	18·1	45·0	9·0	278	2·7
Super., 2 cwt., and Lime, 30 cwt.	24·6	17·5	44·3	9·6	276	2·7
Super., 2 cwt., and Gypsum, 30 cwt.	26·3	16·7	43·8	10·1	280	2·4
No manure	25·3	17·3	45·2	8·8	282	2·6

NOTE.—Table by W. R. Jewell, Agricultural Research Chemist.

TABLE XII.—TOTAL YIELD OF PROTEIN, ETC., OF EACH PLOT, PASTURE MANURIAL TESTS, FIELD 2 S.W., S.W. SECTION, SEASON 1929-30.

(Exclusive of Seventh Cut, for which no Analyses made.)

	Total Dry Matter.	Protein.	Crude Fibre.	Carbo-hydrate, plus Fat.	Silica Free Ash.	Total calories per plot.
No manure	lb. 272	lb. 59	lb. 50	lb. 128	lb. 20	(1,000's) 340
Super., 1 cwt.	421	104	72	193	36	540
Super., 2 cwt.	499	136	81	220	46	647
Super., 3 cwt.	582	157	95	258	55	752
Super., 4 cwt.	625	175	100	273	60	811
No manure	322	76	56	151	27	413
Basic slag, 2 cwt.	504	133	82	228	46	656
Rock phos., 2 cwt.	411	102	71	189	36	529
Nitrate soda, 1 cwt.	363	82	66	172	30	460
Amm. sulph., 1 cwt.	387	87	72	188	31	499
Super., 2 cwt. and Nitrate soda, 1 cwt.	532	135	94	240	46	679
Super., 2 cwt. and Amm. sulph., 1 cwt.	519	127	93	231	47	656
No manure	422	107	74	192	36	544
Pot. sulph., 1 cwt.	406	103	74	187	36	526
Super., 2 cwt. and Pot. sulph., 1 cwt.	588	151	105	258	57	741
Super., 2 cwt., Pot. sulph., Amm. sulph.	530	130	96	239	48	669
Super., 2 cwt. and Lime, 30 cwt.	600	148	105	265	58	751
Super., 2 cwt. and Gypsum, 30 cwt.	618	162	101	271	63	785
No manure	442	112	76	200	39	565

NOTE.—Table compiled by W. R. Jewell, Agricultural Research Chemist.

for the first cut (17/9/29), and gives an indication of the increased mineral value of herbage topdressed with superphosphate. Detailed analyses of the ash constituents were not made for subsequent cuts.

Space does not permit of the inclusion of the complete data in regard to the analyses made, but the following summary, and Tables 11 and 12, show the more important conclusions derived from an examination of the results. Yield gradients, and the small number of check ("No Manure") plots, restrict accurate comparison, but the following generalizations appear to be warranted:

(1) The comparatively high protein contents, low fibre figures, and narrow nutritive ratios indicate that on all plots, as mowed, the herbage was immature.

(2) An appreciable variation in composition on any one plot occurred from cut to cut, and, as previously noted (this *Journal*, April,

1932), this variation appears to be due to variation in the production-rate of the plot.

(3) Compared with "No Manure," phosphatic manures increased the protein content and feeding value, the importance of such increase being relative to the available- P_2O_5 content of the manure used. Nitrogenous manures, nitrate of soda and ammonium sulphate, depressed the protein content and widened the nutritive ratio accordingly. Potash sulphate had no appreciable effect.

(4) Compared with "Super. 2 cwt.," all combinations of 2 cwt. super. and lime, nitrogen, potash, and gypsum, depressed the protein content and produced herbage of inferior feeding value.

(5) It will be noted, in support of statement (2) of this summary, that the protein content and feeding value of the herbage from the different plots follow the same order as the yields shown in part 1 of this report.

APPENDIX I.—DETERMINATION OF VARIATION IN SECTIONS OF "NO MANURE" PLOTS, PASTURE MANURIAL TESTS, FIELD 2 S.W., S.W. SECTION, SEASON 1930-31.

Bay	1.	2.	3.	4.	5.	6.	7.	8.	9.	Totals.
Plot 1	21.7	19.4	15.5	21.5	23.3	24.4	18.2	31.3	16.3	191.6
Plot 6	32.8	24.2	29.6	29.6	22.9	29.1	24.2	31.5	23.4	247.3
Plot 13	34.2	29.6	29.5	25.1	26.2	27.5	28.3	29.0	30.2	259.6
Plot 19	36.2	30.3	30.0	28.4	32.6	33.2	29.7	28.7	26.2	275.3
Totals	124.9	103.5	104.6	104.6	105.0	114.2	100.4	120.5	96.1	973.8

G.M. 27.05

$$GT^2/36 = 948286 \cdot 44/36 = 26341 \cdot 29$$

SUMS OF SQUARES.

Bays.	Plots.	Total.
106,096.90	241,050.10	27,210.08
Div. by 4 26,524.23	Div. by 9 26,783.35	
Subtract 26,341.29	26,341.29	26,341.29
182.94	442.06	868.79

ANALYSIS OF VARIANCE.

	Deg. of Freedom.	Sum sq.	Mean sq.
Bays	8	182.94	22.87
Plots	3	442.06	147.35
Error	24	243.79	10.15
Total	35	868.79	

$$S.E. \text{ single section of plot} = \sqrt{10.15} = 3.18 = 11.8 \%$$

$$S.E. \% (\text{mean of 9 sections}) = 3.9 \%$$

$$\text{For significance, differences should be not less than } (3.9 \times 2\sqrt{2}) \% = 10.7 \%$$

Rose Diseases and Their Control

By B. J. Grieve, M.Sc. (National Rose Society's Research Scholar ; Fred Knigh't and Wyselaskie Scholar)

(Continued from page 556).

XXVI.—CRYPTOSPORIUM MINIMUM,

Laub.

THIS fungus was described by Laubert (1) as parasitizing Climbing roses in Germany in 1907. Infection takes place through wounds on the stem, or after frost injury, the disease being manifested by black irregular spots on the stem. These spots are frequently surrounded by a broad, pale purplish border. The white fruiting bodies of the fungus stand out in contrast against the black of the spots. The spores are colourless, curved, and more or less sausage-shaped, measuring $16.5-27.5\mu \times 2.2-3.8\mu$.

Reference

1. Laubert, R.—Zentralblatt für Bakt. II., Abt. XIX.; pp. 163-168, 1907.

XXVII.—PHOMA OLEANDRINA.

Del.

Delacroix recorded this fungus as being the causal agent of a disease of Laurier roses in France in 1905. In diseased plants the extremities of the leaves, stems, buds or young shoots show a livid brownish colour and die rapidly. The spots are diffused and non-marginal; after a time they become paler in colour, and show small elevations which are the fructifications of the fungus.

MORPHOLOGY.

Mycelium septate, branched; pycnidia flattened transversely, sub-epidermal, with beaks which project through the epidermis. $130-180\mu$ long $\times$ $100-150\mu$ wide. Pycnosporos hyaline, $3-5 \times 2.5-3\mu$; variable in form, often irregularly oval. Sterigmata short, thickened at the base, $3-4\mu$.

Reference

1. Delacroix, G.—Sur une maladie des Lauriers roses due au *Phoma oleandrina* n.s. B.M. Fr. Bd. 21; pp. 186-190, 1905.

XXVIII.—STEREUM PURPUREUM.

Silver Leaf.

The Silver Leaf fungus has been found parasitic on rose plants in England. It is reported to be increasing on Rambler roses.

Reference

1. Brooks, F., and Storey, H.—Jour. Pomol. & Hort. Sci. III.; 3; pp. 117-141, 1923.

XXIX.—KUEHNEOLA ROSAE.

Japanese Rose Rust.

Recorded as seriously affecting *Rosa indica* in Japan in 1918. The fungus forms brown spots on the living leaves and twigs. Morphology. Teleutospores one celled, oblong, cylindrical, smooth thin-walled, $15-22 \times 14-28\mu$.

Reference

- Kaneyoshi, S.—A new Rust Fungus parasitic on cultivated roses. Trans. Sapp. Nat. Hist. Soc. 7; pp. 38-40, 1918.

XXX.—GLOEOSPORIUM ROSAE.

A "Nomen Nudum".

Rose Anthracnose was a term used by Halsted to denote a disease of roses caused by a fungus which he named *Gloeosporium Rosae*. Halsted (3, 4, 5) first described the disease in the United States in 1893, and further descriptions of it by him followed in 1894 and 1895. Infected plants were described as showing pinkish blotches on the leaves and stems, and premature leaf fall was a feature of the disease. Jenkins (7) however after critically examining Halsted's work, comes to the following conclusions:—1. The alleged causative agent of the disease, the fungus *Gloeosporium Rosae* Halst., must be regarded as a "nomen nudum," as insufficient data is given by Halsted even to establish its generic identity. 2. The term "Rose Anthracnose" as used by Halsted must be regarded as without significance in rose

disease literature, as no herbarium specimens of the disease he worked with being available one cannot tell to just what disease he applied the above name. It may also be noted here that the term Rose Anthracnose as used by Sheldon (10) is also without significance. (6.7). References to Halsted's "Rose Anthracnose" occur some few times in the literature, and these are appended below.

References.

1. Anderson, P. J., and others.—Check List of Diseases of Economic Plants in the United States. U.S. Dept. Agric. Bull. 1366, III., 1926.
2. California State Hort. Comm. Fungi and Fungicides. 16 pp., 1905.
3. Halsted, B. D.—Fungous Troubles of the Rose. New Jer. Ag. Exp. Sta. Rept. 13 (1892); pp. 280-283, 1893.
4. Halsted, B. D.—The Anthracnose of the Rose. N.J. Ag. Expt. Sta. Rept. 14 (1893); pp. 401-405, 1894.
5. Halsted, B. D.—Some Fungous Diseases of Ornamental Plants. N.J. Ag. Exp. Sta. Rept. 15 (1894); pp. 362-386, 1895.
6. Jenkins, A. E.—Brown Canker of Rose. The Amer. Rose Annual. pp. 161-182, 1927.
7. Jenkins, A. E.—"Gloeosporium Rosae," a Nomen Nudum. Mycologia Vol. XXIII; No. 3; pp. 223-224, 1931.
8. Schwartz, C. A.—The Parasitic Fungi of New Jersey. N.J. Ag. Expt. Sta. Bull. 313; pp. 52-58, 1917.
9. Seymour, A. B.—Host Index of the Fungi of North America. 732 pp. Harv. Univ. Press, Cambridge, Mass., 1929.
10. Sheldon, J.—Some Rose Anthracnoses. Phytopath. 3, 70, 1913.

XXXI.—SPHACELOMA ON ROSE.

Jenkins in 1929 makes reference to an undetermined species of Sphaceloma causing a disease of roses in the United States of America. No further contribution on the subject has as yet been made.

Reference

- Jenkins, A., and Horsfall, J.—A comparison of two species of Plectodiscella. Mycologia 21; 41-51, 1929.

XXXII.—STILBELLA SP. ON ROSE.

A disease of rose twigs was reported from Trinidad in 1909. Fruiting bodies of the fungus Stilbella were found on the lesions, and the disease was successfully transmitted by inoculation with the spores. The control measures recommended were the cutting back of diseased twigs and the spraying of the bushes with Bordeaux mixture.

Reference.

- A disease of Rose Twigs.—Dept. Agr. Trinidad. Bull. Agr. Inform. Ser. No. 63, p. 91, 1909.

XXXIII.—ALGAL DISEASE. RED RUST.

The disease Red Rust, which is known more commonly from its occurrence on tea bushes in Ceylon, has recently been reported as occurring on rose plants in the West Indies.

Symptoms.—The first outward sign of the disease is the occurrence of dark purplish or black spots up to two centimetres in diameter on the stems. With the coming of the rainy season these become rusty red, due to the development of the sporangia of the alga. The irritation caused by the presence of the parasite sometimes results in hypertrophies of the twigs and stems. In severe cases the separate patches first occurring on the stem may coalesce and envelop it for some distance.

Cause.—The alga *Cephaleuros mycoidea* Karst. is the organism responsible for Red Rust on rose plants according to Nowell (1). There appears, however, to be some uncertainty about the identity of the species of *Cephaleuros* responsible. Petch (2) states that *Cephaleuros parasiticus* Karst. causes stem lesions in the tea disease, and it may be that it is this same species which is responsible for the stem lesions on the rose plants in the West Indies.

Control.—Spraying with Bordeaux mixture carried out early in the dry season will, according to Nowell, prove effective against the disease.

References.

1. Nowell, W.—In Diseases of Crop Plants of the Lesser Antilles; 2 pp. 152-154; and p. 363. West India Committee, London.
2. Petch, T.—Diseases of the Tea Bush. London, 1923; p. 56.

XXXIV.—BRONZING OF ROSE LEAVES.

A bronzing of rose leaves has been reported from England and America, where it is found occurring both on roses grown in the open and under glass.

Symptoms.—The earliest observable symptoms consist of mottling and bronzing of the leaves. These discoloured areas later become more prominent and frequently turn yellow, and finally the leaflets and leaf stalks drop to the ground.

Cause.—Stone and Smith (1) consider that it is a physiological phenomenon of a correlative nature which is brought about, or at least augmented by years of cultivation along certain lines. Stimulation of one part of a plant by cutting may induce marked growth there so that this part utilizes more nutritive substance to the detriment of other parts.

Treatment for this condition consists in effecting improvements in cultivation and in pruning.

Reference.

1. Stone, G., and Smith, R.—The Bronzing of Rose Leaves. Expt. Sta. Rept. Mass. Agr. II.; pp. 156-159, 1899.

XXXV.—VERTICILLIUM WILT OF ROSES.

This disease was first observed in Ontario, Canada, in 1928. Climbing and bush roses appear to be susceptible to the disease.

Symptoms.—Roses attacked by the fungus show severe defoliation, and the main branches and laterals are often killed back. In some cases, however, only a few leaves on the stems wilt and fall off. Infection experiments were carried out by Madden (1) and the progress of the disease followed. The first indication of the disease is noticed at the base of the stems, where the leaves begin to turn yellow. This discolouration is followed in turn by wilting, and finally the leaves of affected branches fall to the ground. A few leaves, however, usually remain adhering to the tips of the most vigorous stems until the following spring. The defoliated stems are almost a sure indication of the presence of the organism in the tissues.

Cause.—The casual agent in this disease is a species of *Verticillium*. The organism in culture produced sclerotia, and is therefore considered to belong to the *Verticillium Dahliae* group. The author (Madden) considers that it is most likely a strain of *Verticillium ovatum* Berkeley and Jackson.

A further paper will doubtless be published on the subject of the etiology of this disease.

Reference.

1. Madden, G. O.—Verticillium Wilt of Roses. Dominion of Canada, Dept. of Agric., Divn. of Botany. Year 1930, pp. 24-25.

FUNGICIDAL PREPARATIONS.

This completes the survey of rose diseases occurring throughout the world. It is thought desirable in conclusion to describe the various fungicidal preparations whose use has been advocated for the control of the foregoing diseases.

The fungicides used fall into two main classes, namely, the copper and sulphur fungicides.

Copper Fungicides

Bordeaux Mixture.—Bordeaux mixture is the most valuable member of the copper fungicidal group. It was first brought into use in

1885, and has remained since then the standard protective fungicide. It consists of a mixture of ill-defined basic compounds of copper formed by the interaction of copper sulphate and lime in water. The fungicidal action of Bordeaux mixture is to be attributed to the formation of soluble copper which may cause the death of the fungus direct or may indirectly by absorption into the host tissue bring about a failure of the fungus to establish infection (2). The following is a common and useful formula employed in making this fungicide:—

Copper sulphate	..	4 lb.
Lime	..	4 lb.
Water	..	50 gallons

This is known as a 4-4-50 mixture. Various other formulas are in use such as the 6-4-50 and the 3-10-50. The latter is an "excess lime" Bordeaux mixture, and causes little or no scorching of delicate foliage.

Method of Making.—Four pounds of copper sulphate are dissolved overnight in 45 gallons of water contained in a barrel. The copper sulphate is best dissolved in the water by suspending it just under the surface in a piece of sacking. Four pounds of stone (fat) lime are slaked gradually, and the milk of lime is made up to 5 gallons. The milk of lime is then strained through a fine sieve into the solution of copper sulphate and stirred vigorously. A flocculent blue precipitate is formed. The Bordeaux mixture is now transferred to a copper lined spraying machine. It is usual to test whether any copper sulphate remains over in the solution owing to there being insufficient lime present as the presence of such copper sulphate would cause a scorching of the leaves. A simple test is as follows:—A clean knife blade is held in the mixture for a few minutes, and then examined to see if any copper has been deposited on it. If there is, more lime should be added. A more delicate test is to add a drop of potassium ferrocyanide solution to a few cubic centimetres of the mixture in a saucer. The presence of free copper is indicated by the drop turning a reddish-brown colour immediately. Lime should be added to the main mixture until the brown colour fails to appear in the test.

Brooks (1) recommends the addition of lead arsenate paste (2 lb. per 50 gallons of Bordeaux mixture) for the control of leaf insects, and the addition of nicotine (1 part of nicotine 95 to 98 per cent. pure, in 2,000 parts

of Bordeaux mixture) for the destruction of aphides.

Burgundy Mixture.—This is sometimes used in place of Bordeaux mixture, but is more liable to scorch young foliage than Bordeaux. Burgundy mixture is prepared according to the formula:—

Copper sulphate	..	4 lb.
Washing soda	..	5 lb.
Water	..	50 gallons

Ammoniacal Copper Carbonate.—Ammoniacal copper carbonate while being an effective fungicide has the advantages of neither discolouring nor scorching the leaves of the plants.

Formula—

Copper carbonate	..	5 oz.
Strong ammonia	..	3 pints
Water	..	50 gallons

It is prepared as follows:—The copper carbonate is made into a thin paste with water, and then 1 pint of the ammonia diluted to 1 gallon with water is added. The mixture is then shaken vigorously and allowed to settle, after which the blue liquid is poured off. Further quantities of diluted ammonia are then added to the residue until the whole is dissolved. The remainder of the water is then added. It is advisable to use this fungicide as soon as made up, as it does not keep well.

The Sulphur Group.

The value of sulphur as a fungicide was first strikingly demonstrated in 1848, when by its use the serious oidium disease of the vine was effectively controlled. Since then sulphur in its various forms (applied as dusts or sprays) has remained the most efficient fungi-

cide for the control of all "powdery mildew" diseases. As described earlier (see Mildew of Roses) sulphur-lead dust, consisting of finely divided sulphur and powdered lead arsenate mixed in the proportions of nine parts of sulphur to one part of lead arsenate, is a very effective fungicide. The addition of the lead arsenate, it may be noted, serves the double purpose of helping the sulphur to adhere to the foliage and of killing off leaf-eating insects.

Other useful sulphur fungicides are the lime sulphur and liver of sulphur sprays.

Lime Sulphur (Calcium polysulphides).—Lime sulphur is made by boiling together lime and sulphur. Concentrated solutions (specific gravity 1.3) which are on the market should be diluted for use to a specific gravity of 1.005 (1 to 59) or 1.003 (1 to 99).

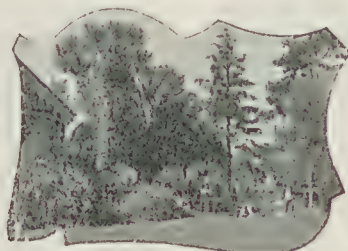
Liver of Sulphur (Potassium polysulphides).—Liver of sulphur is useful for controlling mildew of roses. Potassium sulphide is used at a strength of 4 lb. per 100 gallons of water. A spreader (which allows of a more thorough wetting of the leaves by the spraying solution) is usually added, e.g., saponin at the rate of 2 oz. per 100 gallons of spray fluid.

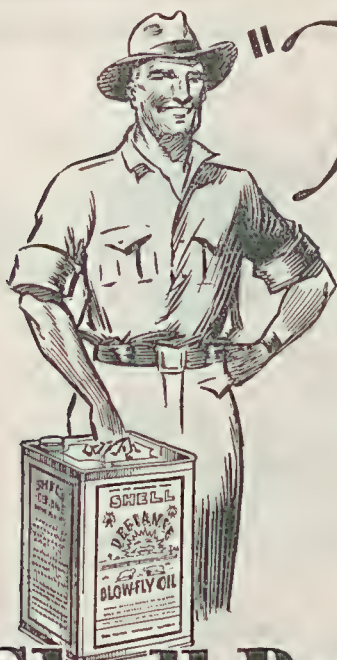
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1. Brooks, F. T.—Plant Diseases, pp. 361-367, 1928.
2. Martin, H.—The Scientific Principles of Plant Protection, p. 83, London, 1928.

ACKNOWLEDGMENT.

In conclusion, the writer wishes to express his indebtedness to Dr. E. McLennan of the Botany School, Melbourne, for suggesting the desirability of undertaking this digest of the rose disease literature and for the help so freely given during its progress.





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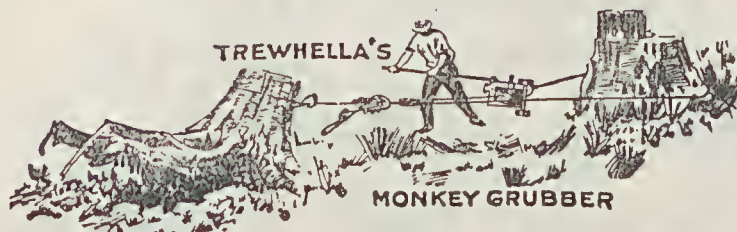
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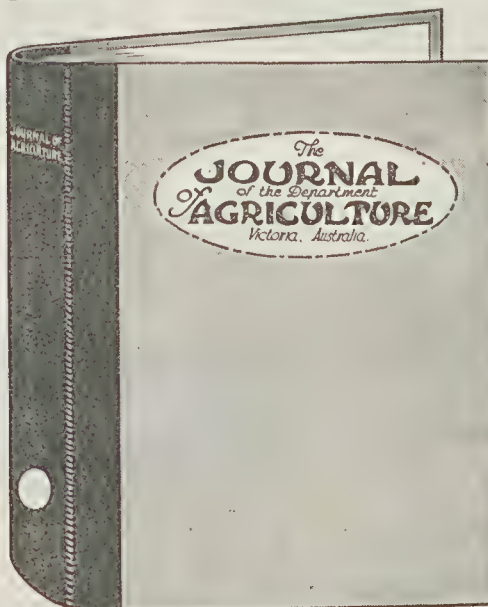
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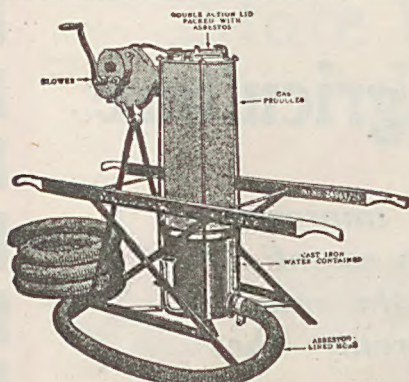
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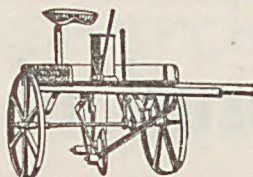
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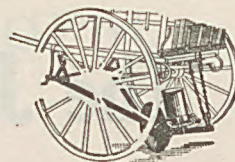
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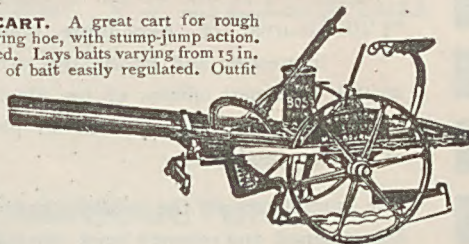
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